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A Review of the Lizard-fishes of the Genus *Synodus* Found in Japan*

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The fishes belonging to the family Synodontidae are important material in Japan for preparing "*Kamaboko*" (mashed flesh of fish) and its price fluctuates considerably with the species used. But there is no concert of opinions among investigators respecting taxonomy of the fishes of this family, especially that of *Synodus*, on the basis of the differences of the external characters. Four of five species hitherto described from Japan as the fishes of the present genus are regarded by some even as one species.

Fortunately, the writer procured a rather large number of specimens referable to the four species noted above and also to one other. His comparative study of these specimens from viewpoints of biometry and anatomy resulted in arriving at a conclusion that it is proper to recognize five distinct species. In the present paper, therefore, these five are fully treated with a view to supplement the descriptions we already have by words, figures and tables of measurements or frequency tables of all the species. The specimens used in this study were obtained from Tôkyô Bay; Miya, Aiti-Ken; Kumano Nada, southeast to Kii Peninsula and Kôti.

In the present paper, the length of body is indicated by a measurement from the tip of the snout to the lower base of caudal fin; the depth of body by that of perpendicular depth at the deepest part; the length of upper jaw by that of the length of premaxillary; the interorbital width by the bony width of the middle part of the interorbital space.

The author expresses his sincere gratitude to Prof. Arata TERAO for his kindness in supervising the present work, and to Prof. Tosiji KAMOHARA and Mr. Genkiti ABE for their labour and time spent in obtaining the specimens.

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* Contributions from the Zoological Laboratory, Imperial Fisheries Institute, No. 74.

Genus *Synodus* GRONOW

Synodus GRONOW, 1763, p. 112. Type: *Salmo synodus* LINNÉ.

Key to the species

a. Pelvic bones with hard laminar posterior processes; pyloric caeca more than 10; peritoneum white; littoral forms.

b. Vertebrae 60 to 64 including hypural; scales in lateral line 60 to 65, those transversely $9\frac{1}{2}$ to $11\frac{1}{2}$ below lateral line; body not much depressed, generally much deeper than half of head; caudal peduncle much higher than diameter of orbit; ventral longer than twice the length of pectoral.....*S. variegatus.*

b′ Vertebrae 53 to 56 including hypural; scales in lateral line 49 to 55, those transversely $5\frac{1}{2}$ to $6\frac{1}{2}$ below lateral line; body depressed, equal to or lower than half of head; caudal peduncle lower, a little lower than, equal to, or a little higher than, diameter of orbit; ventral as long as or shorter than twice the length of pectoral.

c. Base of dorsal short, always shorter than half the length of head; anterior dorsal rays long, extending well beyond tips of succeeding rays when laid back; orbit smaller, much shorter than length of snout; back of body crossed with 10 faint dark cross bars, not extending below lateral line; posterior margin of caudal dark gray; opercle without blotch .....*S. fuscus.*

c′ Base of dorsal long, always longer than half the length of head; anterior dorsal rays scarcely or not reaching tips of succeeding rays when laid back; orbit larger, slightly shorter than length of snout and twice as long as interorbital width; back and sides of body with 8 dark brown cross-bars, extending below lateral line; caudal entirely pale; a large elongate jet-black blotch on upper part of opercle .....*S. hoshinonis.*

a′ Pelvic bones with slender flexible processes posteriorly; pyloric caeca fewer than 10; peritoneum black; deep water forms.

d. Vertebrae 58 to 61 including hypural; 58 to 62 scales in lateral line; upper jaw much projecting beyond lower when mouth is closed; premaxillary equal to or longer than three times the length of orbit; snout constantly much longer than its width or diameter of orbit; interorbital wider, about 3 times in postorbital part of head; dark blotches on sides of body simple .....*S. kaianus.*

d′ Vertebrae 53 to 55 including hypural; scales 49 to 55 in lateral line; jaws subequal anteriorly when mouth is closed; premaxillary always much shorter than 3 times of orbit; snout decidedly wider than long and about as long as orbit; interorbital space narrower than $\frac{1}{4}$ length of postorbital part of head; blotches on sides of body mostly T-shaped or X-shaped .....*S. macrops.*

Synodus variegatus (LACÉPÈDE)

Japanese name: *Aka-eso*

?*Cobitis japonicus* HOUTTUYN, 1782, p. 337 (Nagasaki).

Synodus japonicus JORDAN & HERRE, 1907, p. 516 (Wakanoura; Nagasaki).——JORDAN & STARKS, 1907, p. 492 (Okinawa).——FRANZ, 1910, p. 18 (Yokohama).——SNYDER, 1912 a, p. 403 (Misaki market).——SNYDER, 1912 b, p. 489 (Okinawa).——JORDAN & THOMPSON, 1914, p. 212 (Kôbe).——MATSUURA, 1920, p. 180 (Misaki).——FOWLER, 1925, p. 4 (Guam), p. 23 (Honolulu).——FOWLER, 1928, p. 64, fig. 12 (Honolulu; Hilo; Laysan; French Frigates Shoal; Guam; Rarotonga; Mangareva; Faté; Shortland Is.).——UI, 1929, p. 68 (Kisyû).——SCHMIDT, 1930, p. 22 (Okinawa; Amami-Ôsima).——KAMOHARA, 1930, p. 479 (Kasiwa-zima, Kôti).——KAMOHARA, 1931, p. 82 (Kôti).——SCHMIDT, 1931 b, p. 24 (Kagosima).——FOWLER, 1931, p. 318 (Honolulu market).——KURODA, 1931, p. 91 (Sizuura).——HERRE, 1933 a, p. 12 (Madang, New Guinea).——HERRE, 1933 b, p. 7 (Dumaguete, Oriental Negros).——FOWLER, 1934, p. 391 (Hawaii).

Salmo variegatus LACÉPÈDE, 1803, p. 157, pl. 3, fig. 3.

Saurus variegatus QUOY & GAIMARD, 1824, p. 223, pl. 48, fig. 3 (Mauritius; Maui).——?RICHARDSON, 1846, p. 301 (China).——WEBER & BEAUFORT, 1913, p. 147, fig. 54.

Synodus variegatus SEALE, 1901, p. 63 (Guam).——SEALE, 1902, pp. 15, 16, 20 (Hilo, Honolulu).——BARNARD, 1925, p. 226 (Natal coast).——NORMAN, 1935, p. 106 (Muscat, Arabia; Zanziba; Durban; Mauritius; Maldives; Amboina; Negros, Philippine Is.; China; Wakanoura; Inland Sea of Japan; Ovalau, Fiji Is.; Ruk Is., Bismark Archipelago; Andaman Is.; Hawaiian Is.; New Hebrides).

Salmo varius LACÉPÈDE, 1803, p. 224 (Ile de France).

Saurus varius GÜNTHER, 1864, p. 395.——ISHIKAWA, 1897, p. 22 (Nagasaki; Okinawa).

?*Synodus varius* GÜNTHER, 1880, p. 36 (Ovalau; Fiji)——STEINDACHNER, 1901, p. 513 (Honolulu; Laysan).——JENKINS, 1902 (1903), p. 433 (Honolulu).——SNYDER, 1902 (1904), p. 521 (Honolulu).——JORDAN & EVERMANN, 1903 (1905), p. 63, pl. 2, text-fig. 14 (Hilo; Honolulu).——GILBERT, 1903 (1905), p. 588 (off Molokai; Avan Channel; Bird Is.).——JORDAN & SNYDER, 1905, p. 125 (Honolulu).——JORDAN & SEALE, 1906 (1909), p. 188 (Samoa).——SMITH & POPE, 1906, p. 463 (Kôti; Urado; Yamagawa).

Saurus lucius TEMMINCK & SCHLEGEL, 1846, p. 232, pl. 106, fig. 1 (Simabara).

Synodus synodus BLEEKER (not *Esox synodus* of LINNÉ), 1875, p. 154, pl. 2, fig. 5 (Java).

Synodus dermatogenys FOWLER, 1911 (1912), p. 566, fig. 3 (Hawaii).

Dorsal 13 or 14; anal 9 or 10; pectoral 12 to 14.

Scales in lateral line 60 to 65; those transversely $4\frac{1}{2}$ to $5\frac{1}{2}$ above lateral line, $9\frac{1}{2}$ to $11\frac{1}{2}$ below; 6 or 7 rows of scales on cheek; predorsal scales 17 to 19.

Pyloric caeca 16 (See Fig. 1). Vertebrae 60 to 64 including hypural.

Head 3.25 to 3.64 in body length; depth 5.62 to 6.51; width 5.48 to 5.97; depth of caudal peduncle 15.17 to 18.28; length of snout 14.13 to 16.27; width of snout 12.29 to 14.92; orbit 19.66 to 26.59; upper jaw 4.96 to 5.80; interorbital space 25.84 to 32.77; postorbital part of head 4.89 to 5.46; distance between tip of snout and origin of first dorsal 2.27 to 2.45; base of first dorsal 5.78 to 6.61; longest dorsal ray 6.03 to 7.30; pectoral 7.12 to 8.97; base of anal 10.46 to 11.93; longest anal ray 10.17 to 12.27.

Body not much depressed, generally much deeper than half length of head, and a little lower than width of body which is subequal or somewhat narrower than length of premaxillary. Caudal peduncle rather high, much higher than diameter of orbit. Jaws about equal or upper jaw a little longer anteriorly when mouth is closed; premaxillary extending well beyond eye, a little shorter than postorbital part of head; lower jaw pointed anteriorly, without fleshy knob. Snout broader than long, much longer than diameter of orbit or interorbital width, 1.32 to 1.83 times of the former. Orbit rather small, about as long as (in large specimens) or longer (in young) than interorbital width which is rather deeply concave. Head rugose on each side above and behind eye. Teeth depressible, those in jaws in two irregular series, those of inner series are much enlarged; teeth on tongue large and canine-like, much larger than those on basibranchials which are small and villiform, arranged regularly in six series, sometimes scattered smaller ones between the innermost two series; bands of teeth on palatines in very narrow three rows, teeth much enlarged anteriorly. Nostrils close together, the anterior one with a thin dermal flap.

Origin of dorsal nearly or quite equidistant from tip of snout and origin of adipose fin, anterior dorsal rays not reaching tips of succeeding rays when laid back; the longest dorsal ray much shorter than twice the length of last dorsal ray; base of dorsal long, always much longer than half the length of head. Base of anal much shorter than that of dorsal. Pectorals very short, much shorter than half the length of head, extending beyond base of ventral, but not reaching the origin of dorsal. Ventrals long, slightly or moderately shorter than length of head, but longer than twice the length of pectoral.

Peritoneum white. Pelvic bones with stout laminar processes posteriorly (See Fig. 2).

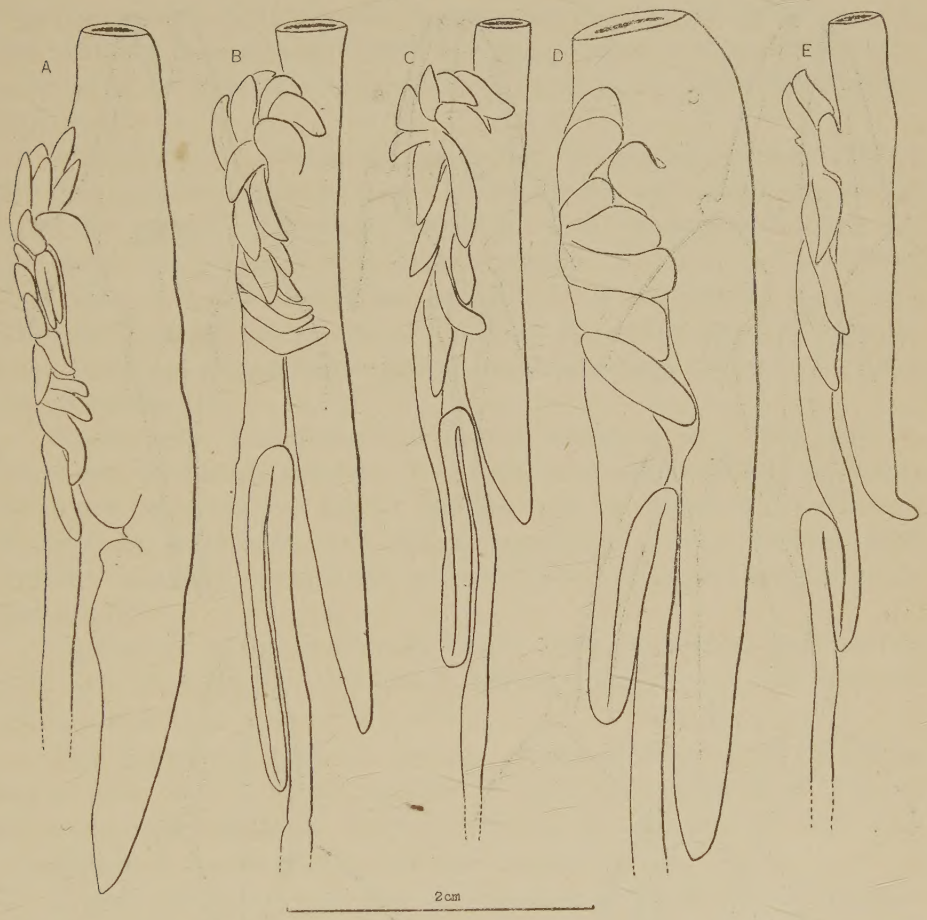

Fig. 1. A, *S. variegatus*; B, *S. fuscus*; C, *S. hoshinonis*; D, *S. kaianus*; E, *S. macrops*.

Body grayish brown above, whitish below, back and sides of body with eight or nine brownish black bars extending below lateral line; cheeks and opercles scattered with small dark blotches; jaws broadly barred with dark. Fins also barred, darker on first dorsal.

Described from 8 specimens 98.3 to 230 mm in body length, procured from Kôti and Tôkyô Bay.

It is very doubtful that HOUTTUYN's *Cobits japonicus* means anything

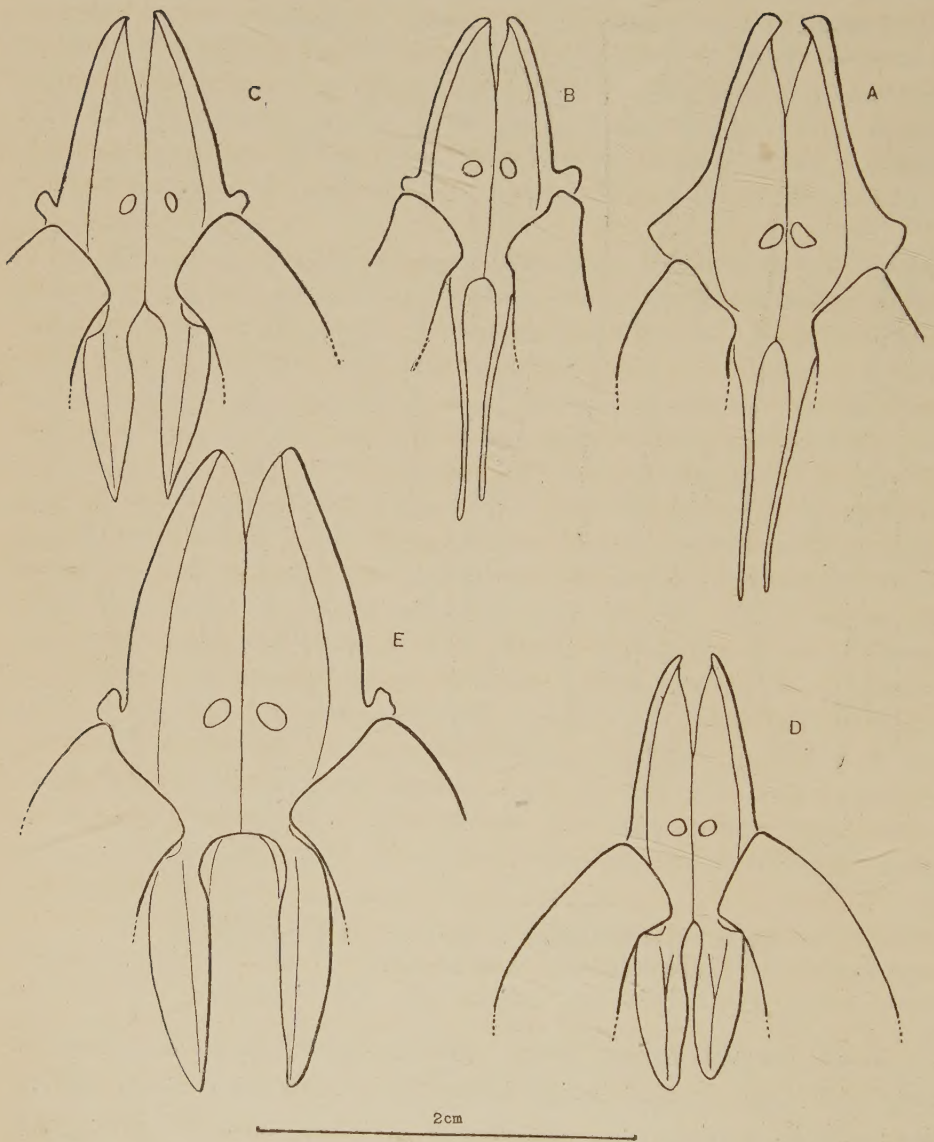

Fig. 2. A, *S. kaianus*; B, *S. macrops*; C, *S. fuscus*; D, *S. hoshinonis*; E, *S. variegatus*.

definite inasmuch as his description* is so imperfect that nearly all the Japanese species of the genera *Synodus* and *Saurida* are referable to it. But JORDAN and HERRE (1907) and many other writers uncritically adopted it, transferred it to the genus *Synodus*, and supplied full descriptions to it.

Now there is no room for doubt that *Synodus japonicus* as defined by these authors represents a distinct species and tallies completely with the present one which should go as *S. variegatus*, although my specimens are provided with larger number of dorsal and anal rays than those of LACÉPÈDE's *Salmo variegatus*,** not to mention agreement with the figure of the species of LACÉPÈDE in having about 10 irregular cross bands extending below lateral line and several distinct cross bars set on caudal.

RICHARDSON commented on *Saurus variegatus* as: "the teeth of upper jaw are small, unequal in height, and disposed in two rows; the lower jaw ones are longer, hastate, and in three or four rows." It may be mentioned that the 8 specimens at my disposal have without exception very large teeth on jaws arranged irregularly in two series.

Agreement of the writer's specimens with LACÉPÈDE's *Salmo varius* is evident in coloration and also in having a large number of vertebrae (60 in the latter).

The specimens observed by the writer are discrepant in having larger head and a fewer number of predorsal scales from those of GÜNTHER's *Saurus varius* which has head $\frac{1}{4}$ or rather more than $\frac{1}{4}$ of the length of the body and predorsal scales 21.

It goes without saying that *Saurus lucius* of TEMMINCK & SCHLEGEL, *Synodus synodus* of BLEEKER (not *Esox synodus* of LINNÉ) and *Synodus dermatogenys* of FOWLER are identical with the present species.

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* The original description of HOUTTUYN's *Cobitis japonicus* translated by JORDAN and SNYDER (1901, p. 748) runs: Head beardless, rather short; mouth in both jaws full of sharp teeth; body, terate and fleshy, like that of a snake or an eel. D. 12; P. 12; V. 8; A. 9. Length 5 inches.

** The following is the original description of *Salmo variegatus* of LACÉPÈDE: Dix rayons à la première dorsale; huit à la nageoire de l'anus et à chaque ventrale; la caudale fourchue; le corps et la queue très-alongés; la tête et les opercules couverts d'écailles semblables à celles du dos; une raie longitudinale, rouge, chargée de taches noires, et placée de chaque côté de l'animal, au-dessus d'une sériè d'espaces alternativement jaunes et noirs; les nageoires variées de noir et de rouge.

The present species is closely allied to the Atlantic species *Synodus synodus* (LINNÉ) in many respects, but separated from it, amongst others, in having larger number of scales (scales in lateral line 54 to 58 in the latter).

Habitat: East Africa; Red Sea; Indian ocean; East Indies; Oceania; Hawaii; Coast of China; Riu Kiu Islands and Japan, north to Tôkyô Bay.

Synodus fuscus TANAKA

Japanese name: *Suna-eso*

Synodus fuscus TANAKA, 1917, p. 38 (Tôkyô fish market).——JORDAN & HUBBS, 1925, p. 154 (Mikawa Bay).——UI, 1929, p. 69 (Kisyû).——KAMOHARA, 1933, p. 240 (Kôti).

Dorsal 10 to 12; anal 8 to 11; pectoral 11 to 13; scales in lateral line 49 to 55; those transversely $3\frac{1}{2}$ above lateral line, $5\frac{1}{2}$ or $6\frac{1}{2}$ below; 6 rows of scales on cheek; predorsal scales 15 to 18.

Pyloric caeca 12 to 18 (See Fig. 1). Vertebrae 53 to 56.

Head 3.51 to 4.13 in body length; depth 7.45 to 9.84; width 5.83 to 8.60; depth of caudal peduncle 19.43 to 24.80; length of snout 12.86 to 17.50; width of it 12.73 to 15.75; orbit 19.25 to 26.57; premaxillary 5.68 to 7.0; interorbital space 25.72 to 41.79; postorbital part of head

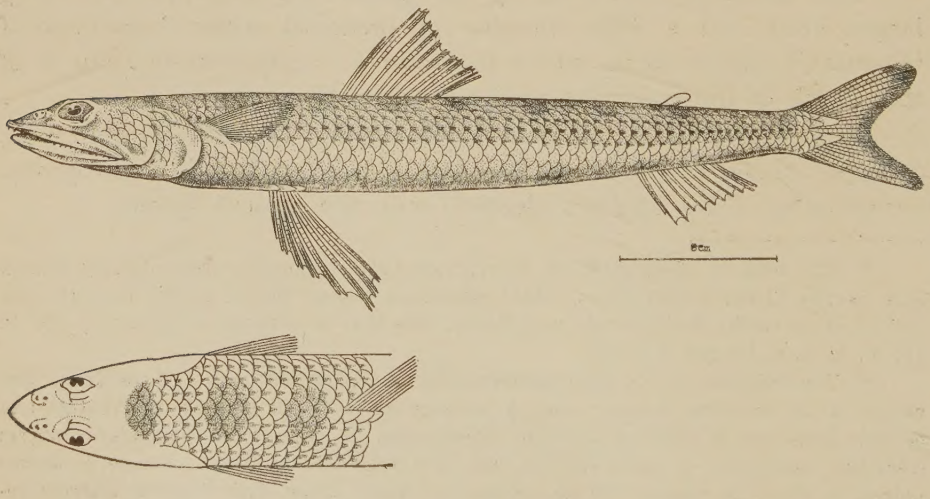

Fig. 3. *S. fuscus* TANAKA

5.48 to 7.20; distance between tip of snout and origin of first dorsal 2.23 to 2.49: base of first dorsal 7.20 to 9.24; longest dorsal ray 6.30 to 7.64; pectoral 7.96 to 9.30; ventral 4.38 to 5.13; base of anal 9.61 to 12. 67; longest anal ray 11.68 to 15.18.

Body depressed, as deep as or lower than half length of head, and always lower than width of body which is narrower than length of premaxillary. Caudal peduncle low, a little lower than, equal to, or a little higher than diameter of orbit. Upper jaw somewhat longer than lower one when mouth is closed; premaxillary extends well beyond eye, about as long as the postorbital part of head; lower jaw pointed anteriorly, devoid of fleshy knob. Snout broader than long, much longer than diameter of orbit or interorbital width. Orbit small, but always longer than interorbital width which is shallowly concave. Head somewhat rough above and behind eyes. Teeth depressible, those in jaws arranged in a smaller outer and a larger inner rows; teeth on tongue larger than those of basi-branchials, arranged irregularly in about four series; palatine teeth set in three rows, several anterior teeth of the innermost series are somewhat enlarged. Nostrils close together, the anterior one with a fleshy flap.

Origin of dorsal midway between tip of snout and origin of second dorsal or somewhat nearer to the latter than to the former; anterior dorsal rays very long, extending well beyond tips of succeeding rays when laid back; the longest dorsal ray twice as long as the last ray; base of dorsal short, always somewhat shorter than half the length of head. Base of anal much shorter than that of dorsal. Pectorals very short, shorter than half the length of head, not extending to the initial of first dorsal. Ventral usually shorter than twice the length of pectoral.

Peritoneum white. Pelvic bones with hard laminar posterior processes (See Fig. 2).

Body grayish above, whitish below; back crossed with 10 faint dark gray bars, not extending below lateral line, of which 3 before first dorsal, 1 below first dorsal, 3 between dorsals, and 3 behind adipose fin; base and posterior margin of caudal dark gray; other fins pale.

The above description is based upon 58 specimens, measuring 117.0 to 231.5 mm in body length, all procured from inner half of Miya Bay, Aiti Prefecture: the accompanying figures are drawn from a male specimen, 151.0 mm in body length, Imp. Fish. Inst. Fish Sp. No. 2259.

The writer's specimens agree fairly well with TANAKA's *Synodus*

fuscus,* except in having somewhat lower body (depth 7.0 times in body length in the latter).

Lately, TANAKA (1931) synonymized *S. fuscus*, *S. macrops* TANAKA and *S. hoshinonis* TANAKA with *S. japonicus* (HOUTTUYN). But *S. fuscus* and *S. japonicus*, which is identical with *S. variegatus* (LACÉPÈDE), are distinguishable as given in the following lines (See also Figs. 3 to 5 and Tables I and II):

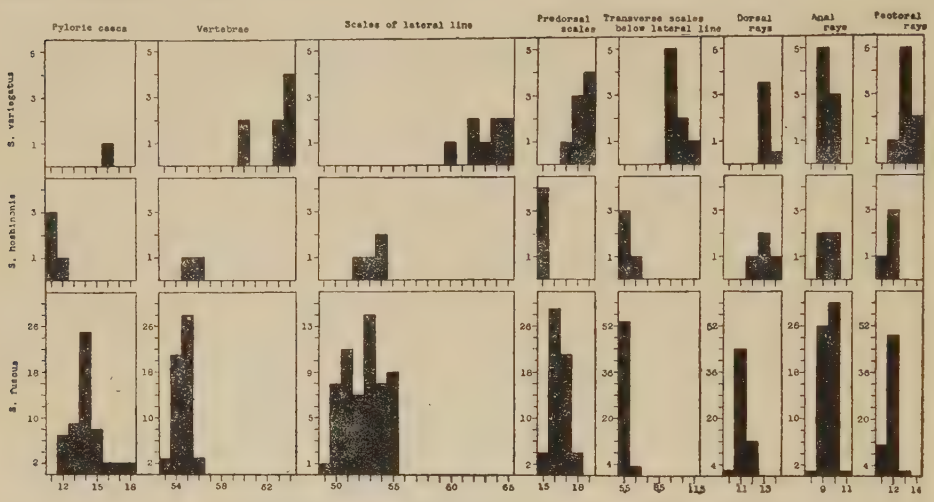

Fig. 4. Frequencies of pyloric coeca, vertebrae, scales, and fin-rays of *S. variegatus*, *S. hoshinonis* and *S. fuscus*.

S. fuscus	*S. variegatus*
1. Vertebrae 53 to 56 including hypural.	1. ..... 60 to 64.
2. Scales in lateral line 49 to 55, those transversely $5\frac{1}{2}$ or $6\frac{1}{2}$ below lateral line.	2. ..... 60 to 65, and $9\frac{1}{2}$ to $11\frac{1}{2}$.
3. Anterior dorsal rays very long, extending well beyond tips of succeeding rays when laid back; the longest dorsal ray twice as long as the last ray; base of dorsal shorter than half the length of head.	3. ..... low, not reaching tips of succeeding rays when laid back; ..... much shorter than twice the length of last dorsal ray; ..... always much longer than half the length of head.

* The original description of this species was translated by JORDAN & HUBBS (1925, p. 154).

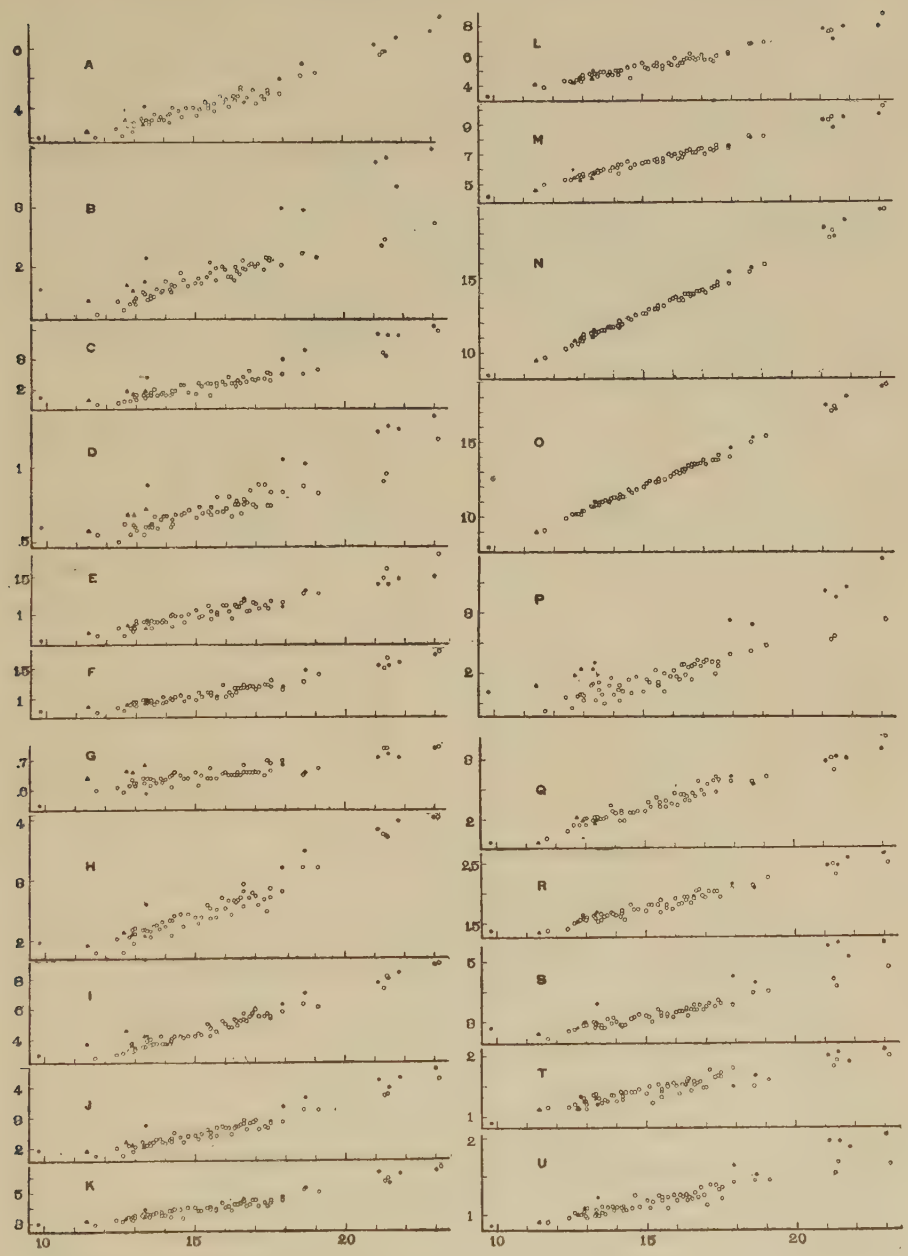

Fig. 5. Showing dimension (in cm) of body parts in relation to body length of *S. variegatus*, *S. fuscus*, and *S. hoshinonis*.

●, *S. variegatus*; ○, *S. fuscus*; ▲, *S. hoshinonis*.

A, length of head; B, depth of body; C, width of body; D, depth of caudal peduncle; E, length of snout; F, width of snout; G, diameter of orbit; H, length of upper jaw; I, interorbital width; J, length of postorbital part of head; K, dist. from tip of snout to pectoral; L, dist. from tip of snout to ventral; M, dist. from tip of snout to first dorsal; N, dist. from tip of snout to second dorsal; O, dist. from tip of snout to anal; P, length of base of first dorsal; Q, length of longest dorsal ray; R, length of pectoral; S, length of ventral; T, length of base of anal fin; U, length of longest anal ray.

4. Body depressed, depth equal to or lower than half the length of head and 7.45 to 9.84 in body length.
5. Caudal peduncle low, a little lower than, equal to, or a little higher than diameter of orbit, its depth 19.43 to 24.80 in body length.
6. Ventral shorter than twice the length of pectoral and 4.38 to 5.13 in body length.
7. Back of body with 10 faint dark bars, not extending below lateral line; posterior margin of caudal dark gray.

4. ..... not much depressed, much deeper than half the length of head and 5.62 to 6.51 in body length.
5. ..... higher, always much higher than diameter of orbit, its depth 15.17 to 18.28 in body length.
6. ..... longer than twice the length of pectoral and 3.54 to 4.32 in body length.
7. Back and sides of body with eight or nine blackish brown bars, extending below lateral line; caudal barred.

Specimens 58 in number were obtained from Miya, Aiti Prefecture.

Habitat: Mikawa Bay; Wakayama; Kumano-Nada and Kôti.

Synodus hoshinonis TANAKA

Japanese name: *Hosino-eso*

Synodus hoshinonis TANAKA, 1917, p. 38 (Hiro, Kisyû).——UI, 1929, p. 69 (Kisyû). ——KAMOHARA, 1932, p. 148 (Kôti).

Synodus similis MCCULLOCH, 1921, p. 167, pl. 8, fig. 2.——NORMAN, 1935, p. 115 (Arafura Sea; Inland Sea of Japan; Nagasaki).

Dorsal 12 to 14; anal 9 or 10; pectoral 11 or 12. Scales in lateral line 52 to 54; those transversely $3\frac{1}{2}$ above lateral line, $5\frac{1}{2}$ or $6\frac{1}{2}$ below; 5 rows of scales on cheek; predorsal scales 15.

Pyloric caeca 11 or 12 (See Fig. 1). Vertebrae 55 or 56 including hypural.

Head 3.51 to 3.86 in body length; depth 7.43 to 8.06; width 6.51 to 7.01; depth of caudal peduncle 18.47 to 20.04; length of snout 14.94 to 16.22; width of it 13.13 to 14.46; orbit 16.79 to 17.92; premaxillary 5.95 to 6.43; interorbital space 27.61 to 34.86; postorbital part of head 5.72 to 6.43; distance between tip of snout and origin of

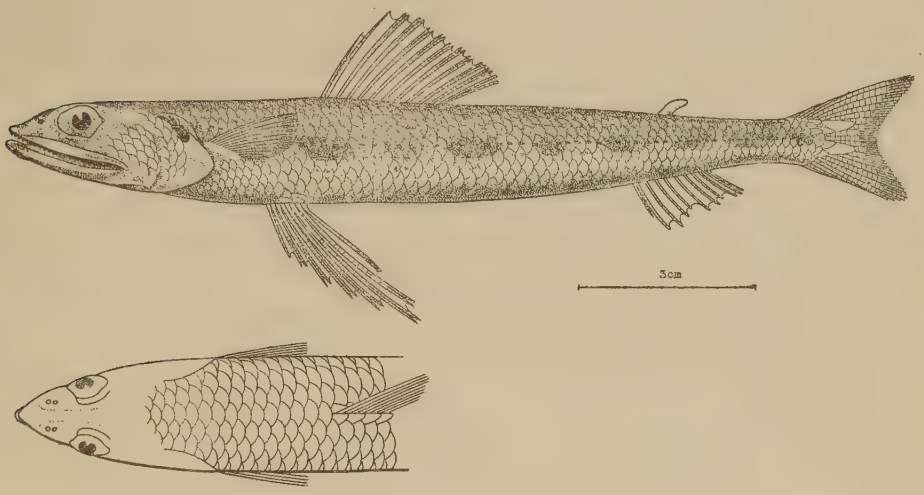

Fig. 6. *S. hoshinonis* TANAKA

first dorsal 2.35 to 2.49; base of first dorsal 6.23 to 6.43; longest dorsal ray 6.26 to 7.14; pectoral 8.06 to 8.46; ventral 4.36 to 4.54; base of anal 10.20 to 11.04; longest anal ray 12.06 to 13.17.

Body moderately depressed, as deep as or a little lower than half the length of head and somewhat lower than width of body which is scarcely narrower than length of premaxillary. Caudal peduncle somewhat lower than diameter of orbit. Jaws equal, or lower jaw slightly projecting beyond the upper when mouth is closed; premaxillary extending well beyond eye, about as long as the postorbital part of head; lower jaw sharply pointed anteriorly, devoid of fleshy knob. Snout decidedly broader than long and slightly longer than orbit, 1.06 to 1.18 times of it. Orbit large, twice as long as the interorbital width, which is usually shallowly concave. Top of head rugose above and behind the eyes. Teeth all depressible, arranged irregularly in two rows on jaws, the inner teeth enlarged; teeth on tongue running regularly in 4 or 5 series, clearly much larger than those on basi-branchials. Nostrils close together, the anterior one of which is provided with a triangular thin dermal flap.

Origin of first dorsal a little nearer to tip of snout than to origin of adipose fin; anterior dorsal rays scarcely or not reaching tips of succeeding rays when the fin laid back; base of first dorsal long, always longer than half the length of head. Base of anal much

shorter than that of dorsal. Pectoral shorter than half the length of head, not reaching origin of first dorsal. Ventral as long as or shorter than twice the length of pectoral.

Peritoneum white. Pelvic bones with hard laminar processes posteriorly (See Fig. 2).

Grayish brown above, whitish below, back and sides with 8 dark brown cross-bars, of which 1 before first dorsal, 2 below first dorsal, 3 between dorsals and 2 behind adipose fin, extending below lateral line, alternately darker and fainter ones; a similar but roundish blotch on base of caudal; a large elongated and curved jet black blotch on upper part of opercle.

Described from 4 specimens, measuring 114.2 to 133.0 mm in body length and drawn from a male specimen of 133.0 mm (155.0 mm in total length), Imp. Fish. Inst. Fish Sp. No. 4823; all procured from Kôti.

The writer's specimens generally quite agree with Tanaka's *Synodus hoshinonis** in various characters except in having somewhat narrower bony interorbital space than the latter one.

Synodus similis of McCulloch and also of Norman are obviously identical with the present species.

The present species undoubtedly differs from *S. variegatus* at least in having the following important characters (See Figs. 4 to 6 and Tables 1 and 3): 1) Vertebrae 55 or 56 including hypural; 2) scales larger, 52 to 54 in lateral line; those transversely $5\frac{1}{2}$ or $6\frac{1}{2}$ below lateral line; 3) body depressed, as deep as or a little lower than half the length of head, its greatest depth 7.43 to 8.06 times in body length; 4) caudal peduncle somewhat lower than diameter of orbit and 18.47 to 20.04 times in body length; 5) ventral short, equal to or shorter

* The following is an English translation of the original Japanese description of *Synodus hoshinonis* Tanaka: Head $3\frac{5}{6}$ in body length; depth $7\frac{2}{7}$. Diameter of eye $4\frac{1}{2}$ in head; interorbital width $5\frac{1}{7}$; its bony width $7\frac{1}{6}$; snout 4; depth of caudal peduncle $5\frac{1}{7}$. Dorsal rays 13; anal 9; pectoral 12; ventral 8; branched rays of caudal 17. Scales 3.5–55–5.5. Pectoral nearly reaches origin of dorsal; ventral long, extending beyond posterior end of bese of dorsal and nearly reaching to posterior end of depressed last dorsal ray. Caudal forked. Color in formalin closely resembles that of *Synodus macrops* Tanaka, but differs from it in having on sides of body ten nearly T-shaped blotches. Posterior end of opercle marked with a large dark black blotch. 161 mm in length measured to tip of upper caudal lobe. Procured from Hiro, Prov, Kisyû by Isaburô Hoshino. The present species is characterized by having long ventral and opercle marked with a black blotch.

than twice the length of pectoral and 4.36 to 4.54 in body length; 6) a large elongated jet black blotch on upper part of opercle.

The differences between this species and *S. fuscus* may be given as follows (See Fgs. 3 to 6 and Tables 2 and 3):

S. hoshinonis	*S. fuscus*
1. Orbit larger, slightly shorter than snout, 1.06 to 1.18 times in it and 16.79 to 17.92 in body length.	1. ..... much shorter than snout, 19.25 to 26.57 in body length.
2. Base of dorsal longer, always longer than half the length of head; anterior dorsal rays scarcely or not extending tips of succeeding rays when laid back.	2. ..... shorter, always shorter than half the length of head; .....long, extending well beyond tips of succeeding rays when laid back.
3. Dark cross bars extending below lateral line; a large jet black blotch on upper part of opercle; caudal uniformly pale.	3. ..... not extending below lateral line; opercle devoid of blotch; posterior margin of caudal broadly dark gray.

Four specimens from Kôti have been examined.

Habitat: Arafura Sea; Nagasaki; Kôti and Wakayama.

Synodus kaianus (GÜNTHER)

Japanese name: *Hanatogo-eso*

Saurus kaianus GÜNTHER, 1880, p. 50, pl. 23, fig. c (Ki Is. in 129 fathoms).——WEBER & BEAUFORT, 1913, p. 148 (after GÜNTHER).

Synodus kaianus GILBERT, 1903 (1905), p. 588 (Pailolo Channel off northern Maui at depths 122 to 178 fathoms).——JORDAN & SEALE, 1905 (1906), p. 188 (deep seas of Hawaii; Arafura Sea).——FOWLER, 1928, p. 65.——NORMAN, 1935, p. 113.——*Kamohara*, 1937, p. 424 (Tosa).

Dorsal 9 to 12; anal 9 to 11; pectoral 11 to 13. Scales in lateral line 58 to 62; a series of transverse scales $3\frac{1}{2}$ above lateral line, $5\frac{1}{2}$ or $6\frac{1}{2}$ below; predorsal scales 16 to 18; scales on cheek 6 rows.

Pyloric caeca 6 to 8 (See Fig. 1). Vertebrae 58 to 61 including hypural.

Head 3.53 to 3.93 in body length; depth 6.19 to 9.05; width 6.18 to 10.34; depth of caudal peduncle 18.94 to 22.72; length of snout

10.62 to 13.00; width of same 13.17 to 16.93; orbit 16.15 to 22.05; premaxillary 5.62 to 6.60; interorbital space 18.38 to 23.50; postorbial part of head 6.47 to 7.94; distance between tip of snout and origin of first dorsal 2.29 to 2.46; base of first dorsal 7.88 to 9.62; longest dorsal ray 7.32 to 8.61; pectoral 7.02 to 8.59; base of anal 9.69 to 12.93; longest anal ray 14.06 to 18.42.

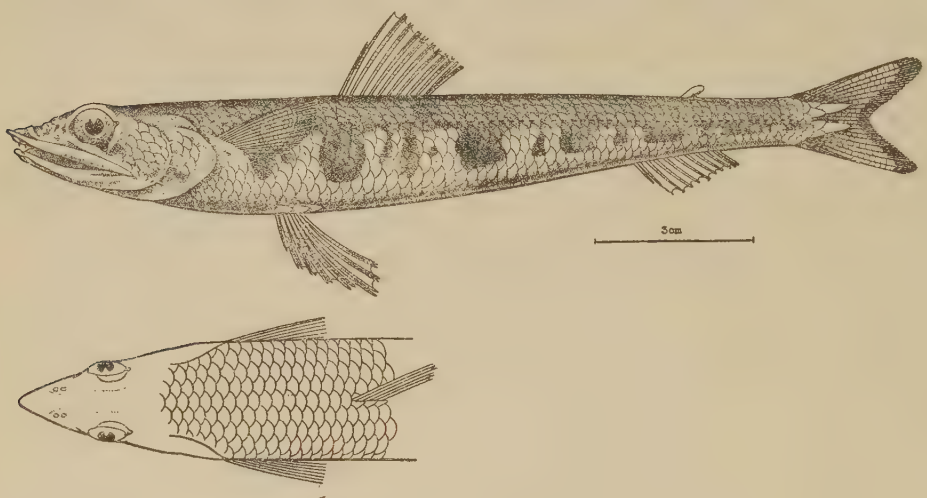

Fig. 7. *S. kaianus* (GÜNTHER)

Body not much depressed, quadrate in cross section, its depth slightly higher than, equal to, or somewhat lower than width of body. Depth of caudal peduncle as deep as or a little lower than diameter of orbit. Upper jaw much projecting beyond lower when mouth is closed; premaxillary equal to or longer than 3 times the length of orbit; lower jaw narrow and pointed anteriorly, without fleshy knob. Snout sharply pointed, invariably much longer than width or diameter of orbit. Eye moderate. Interorbital space slightly concave and wide, about 3 times in postorbital part of head. Upper surface of head somewhat rough above and behind eyes. Teeth arranged irregularly in 2 rows on jaws and on palatines, those of the inner series on the former enlarged; tongue flattened laterally and sharply pointed, armed with about 3 rows of canine-like teeth, much larger than those of basibranchials. Nostrils close together, the anterior one provided with a thin dermal flap.

Origin of first dorsal a little nearer to tip of snout than to origin of second dorsal; longest dorsal ray much more than twice the length of the last ray and mostly somewhat shorter than $\frac{1}{2}$ length of head; anterior dorsal rays scarcely or rarely not reaching tips of succeeding rays when laid back; base of the dorsal decidedly shorter than half the length of head, but longer than base of anal. Ventral very short, always much shorter than twice the length of pectoral and about half the length of head. Pectorals not extending to origin of dorsal.

Peritoneum jet black. Pelvic bones with slender flexible posterior processes (See Fig. 2).

Grayish brown above, abruptly paler below; sides of body with a series of 8 to 10 dark brown, alternately larger and smaller blotches; fins pale, without any marks.

Described from 24 specimens, obtained from deep water of Kumano-Nada, southeast to Kii Peninsula, ranging 75.0 to 204.5 mm in body length and the accompanying figures are drawn from a male specimen, measuring 149.0 mm in body length (175.0 mm in total length), Imp. Fish, Inst. Fish Sp. No, 2102.

The writer's specimens generally agree well with *Saurus kaianus* of GÜNTHER and *Synodus kaianus* of various writers in various characters.

Differs from *S. variegatus*, *S. fuscus* and *S. hoshinonis* at least in having the pelvic bones armed with slender cartilaginous posterior processes, peritoneum jet black, fewer pyloric caeca (6 to 8 in number), and snout much projecting beyond the lower jaw (See Figs. 1, 2 and 7).

Habitat: Arafura Sea; Oceania; Hawaii; Kôti and Kumano-Nada.

Synodus macrops TANAKA

Japanese name: *Tyôtyô-eso*

Synodus macrops TANAKA, 1917, p. 38 (Tôkyô fish market).——UI, 1929, p. 68 (Kisyû). ——KAMOHARA, 1932, p. 148 (Kôti).

Dorsal 10 to 12; anal 10 or 11; pectoral 11 to 13; 49 to 55 scales in lateral line; $3\frac{1}{2}$ scales above lateral line and $5\frac{1}{2}$ scales below transversely; 14 to 17 scales predorsally; 6 rows of scales on cheek.

Pyloric caeca 5 or 6 (See Fig. 1). Vertebrae 53 to 55 including hypural.

Head 3.86 to 4.18 in body length; depth 6.90 to 9.31; width 6.85 to 8.41; depth of caudal peduncle 19.08 to 21.79; length of snout 15.17 to 17.44; width of it 13.19 to 15.89; orbit 14.59 to 17.88; premaxillary 6.53 to 7.39; interorbital space 27.81 to 38.32; postorbital part of head 7.03 to 7.85; distance from tip of snout to origin of first dorsal 2.33 to 2.56; longest dorsal ray 6.50 to 7.86; pectoral 7.53 to 8.94; base of anal 9.04 to 10.94; longest anal ray 13.61 to 17.44.

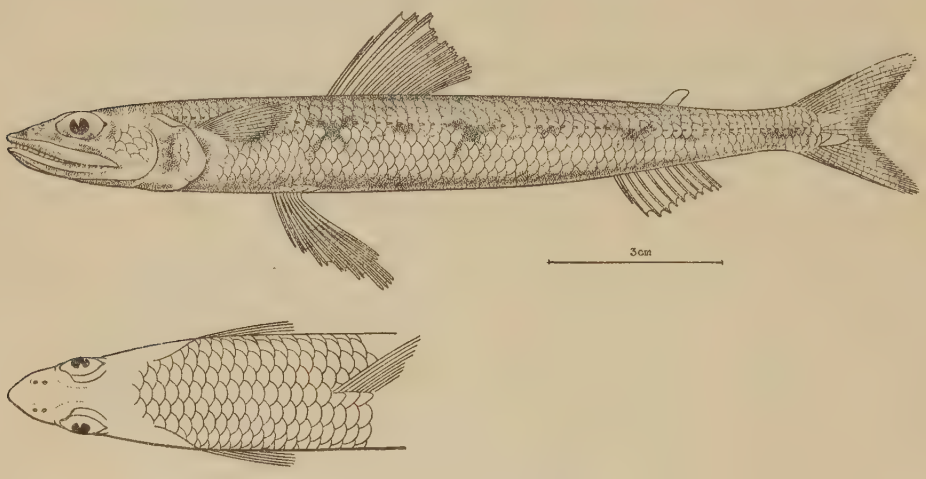

Fig. 8. *S. macrops* Tanaka

Body depressed, lower than wide, usually as deep as or lower than half length of head. Caudal peduncle always lower than diameter of orbit. Jaws equal or upper jaw scarcely longer than the other when mouth is closed; premaxillary much shorter than 3 times the length of orbit; lower jaw rather sharply pointed anteriorly, without fleshy knob. Snout always wider than long and generally as long as orbit which is very large. Interorbital space shallowly concave, narrower than $\frac{1}{4}$ length of postorbital part of head. Upper surface of head rugose above and behind eyes. Teeth arranged irregularly in 2 rows on jaws and on palatines, those of inner series enlarged; tongue much compressed and sharply pointed, armed with 3 rows of canine-like teeth; they are larger than those of basi-branchials which are villiform. Nostrils close together, the anterior one with a very long thin dermal flap.

Origin of dorsal nearer to tip of snout than to origin of adipose fin; anterior dorsal rays extending to tips of succeeding rays when laid back; the longest dorsal ray much longer than twice the length of the last ray; base of dorsal about half the length of head, and much longer than that of anal. Ventrals moderate, always shorter than twice the length of pectoral which is not extending to dorsal.

Peritoneum grayish black. Pelvic bones with slender cartilaginous processes posteriorly (See Fig. 2).

Grayish brown above, paler below; sides with a series of about 8 dark T-shaped or X-shaped alternately larger and smaller blotches; a large elongated but inconspicuous dark gray blotch on anterior part of opercle; fins pale, without any markings.

The above description is based upon 22 specimens, ranging from 133.5 to 181.0 mm in total length and accompanying figures are drawn from a female specimen, Imp. Fish. Inst. Fish Sp. No. 1057, measuring 160 mm in total length; these specimens were all obtained from deep water of Kumano-Nada, southeast to Kii Peninsula.

It may be mentioned that TANAKA's *Synodus macrops** is included within the range of variations of the writer's specimens as shown in the accompanying figures and tables.

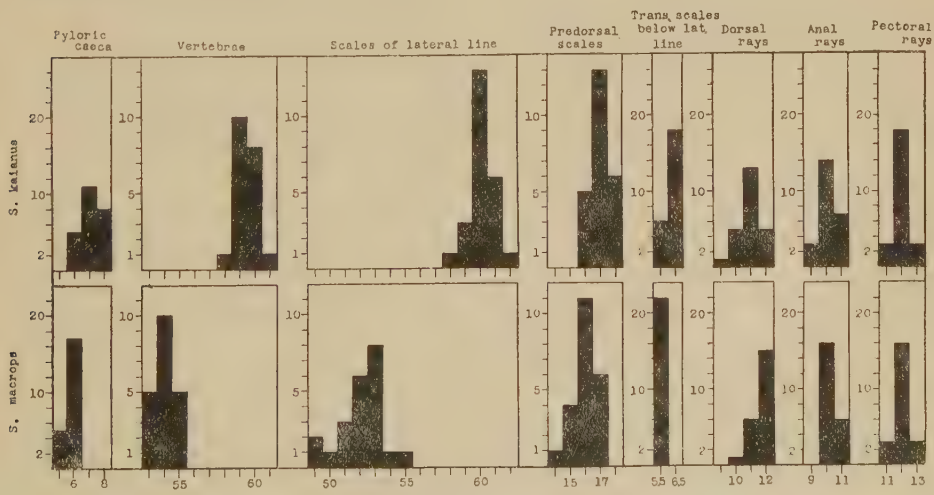

Fig. 9. Frequencies of pyloric caeca, vertebrae, scales, and fin rays of *S. kaianus* and *S. macrops*.

The present species is much nearer to *Synodus kaianus* (GÜNTHER) than any other Japanese species of the present genus in having the pelvic bones armed with slender flexible processes posteriorly, pyloric

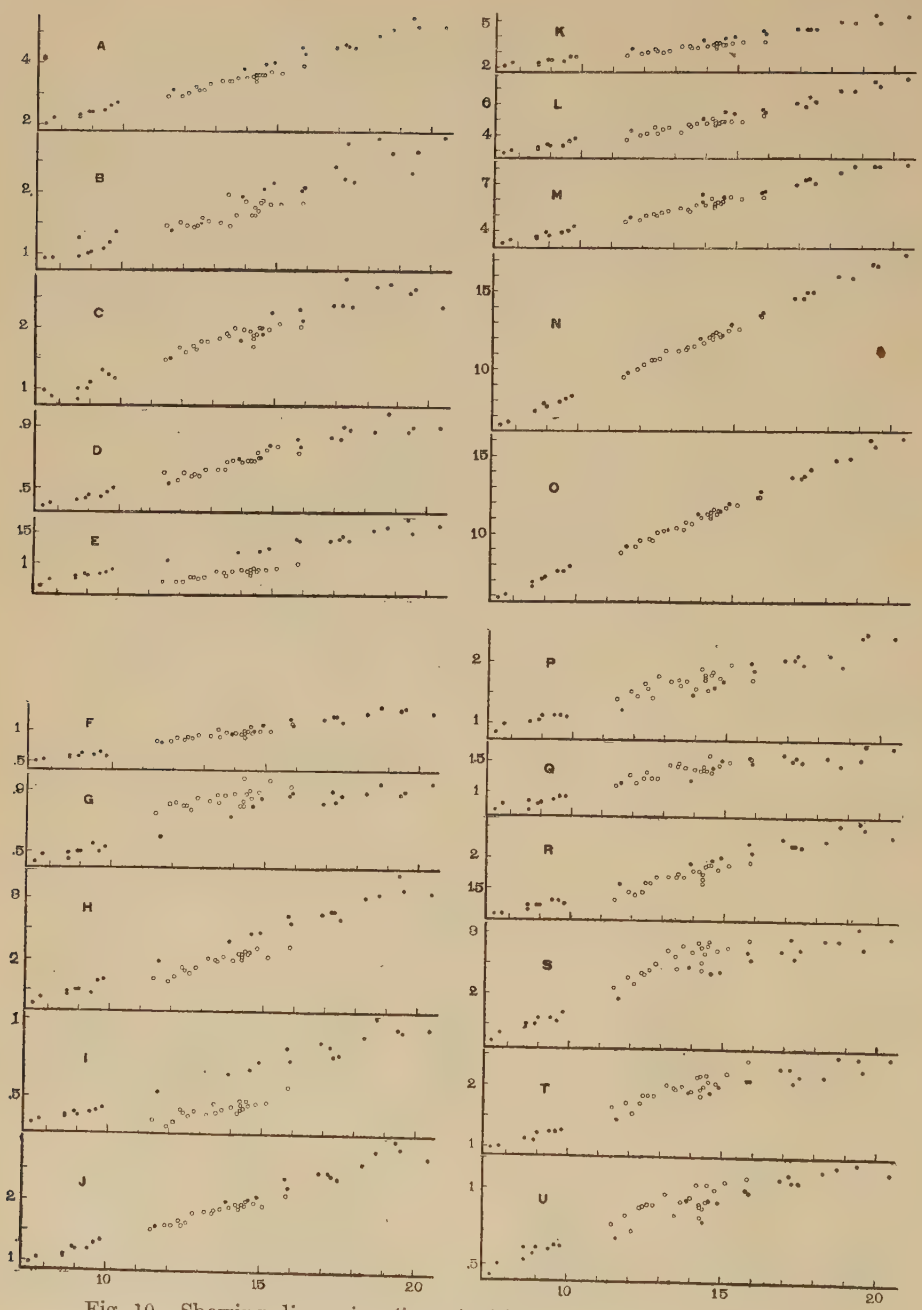

Fig. 10. Showing dimension (in cm) of body parts in relation to body length of *S. kaianus* and *S. macrops*.

●, *S. kaianus*; ○, *S. macrops*.

A, length of head; B, depth of body; C, width of body; D, depth of caudal peduncle; E, length of snout; F, width of snout; G, diameter of orbit; H, length of upper jaw; I, Interorbital width; J, length of postorbital part of head; K, dist. from tip of snout to pectoral; L, dist. from tip of snout to ventral; M, dist. from tip of snout to first dorsal, N, dist. from tip of snout to second dorsal; O, dist. from tip of snout to anal; P, length of base of first dorsal; Q, length of base of anal; R, length of pectoral; S, length of ventral; T, length of longest dorsal ray; U, length of longest anal ray

caeca always fewer than 10 and black peritoneum (See Figs. 1 and 2.), but the differences between these 2 species may be given as follows (See Figs. 7 to 10 and Tables 4 and 5):—

S. macrops	*S. kaianus*
1. Vertebrae 53 to 55 including hypural.	1. ..... 58 to 61.
2. Scales in lateral line 49 to 55.	2. ..... 58 to 62.
3. Jaws subequal when mouth is closed.	3. Upper jaw much projecting beyond the lower when mouth is closed.
4. Premaxillary shorter, always much shorter than 3 times the length of orbit and 6.50 to 7.40 in length of body.	4. ..... equal to or longer than 3 times of orbit and 5.60 to 6.60 in body length.
5. Interorbital space narrower than $\frac{1}{4}$ length of postorbital part of head, 27.81 to 38.32 in body length.	5. ..... wider, about 3 times in postorbital part of head, 18.38 to 23.50 in body length.
6. Snout invariably wider than long, and about as long as orbit, 15.17 to 17.44 in body length.	6. ..... always much longer than wide or diameter of orbit, 10.62 to 13.00 in body length.
7. Blotches on sides of body mostly T-shaped or X-shaped.	7. ..... simple, not T-shaped nor X-shaped.

Twenty-two specimens procured from deep water of Kumano-Nada, southeast to Kii Peninsula.

Habitat: Wakayama, Kumano-Nada and Kôti.

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* The following is a translation of the original description of *Synodus macrops* TANAKA: Head about 4 in body length; depth $7\frac{2}{5}$. Diameter of eye $3\frac{2}{3}$ in head; its exposed part $4\frac{5}{8}$; bony interorbital width $8\frac{1}{4}$; interorbital width $5\frac{2}{7}$; snout $3\frac{2}{3}$; depth of caudal peduncle $2\frac{2}{7}$. Dorsal rays 12; anal 11; pectoral 12; ventral 8; branched rays of caudal 16. Scales 3.5–52–5.5. Snout as long as eye. Color in formalin bluish gray, whitish below, marked on the sides with five large trilobate blotches and furnished between each of them with similar blotch of smaller size. Fins pale, nearly without blotch. 173 mm in total length, measured to tip of upper caudal lobe. Tôkyô fish market. The present fish is characterized by having feeble body and eye as long as snout.

Note

Two groups may be recognized in the five species described in the present paper by the differences of the shape of posterior processes of pelvic bones, color of peritoneum and the number of pyloric caeca (See Figs. 1 and 2). In the first group including *S. variegatsu, S. fuscus* and *S. hoshinonis,* which are all littoral forms, the posterior processes of pelvic bones are stout and laminar, the peritoneum white and pyloric caeca more than 10. While in the second group including two deep-water species *S. kaianus* and *S. macrops,* the posterior processes of pelvic bones are very slender and feeble, the peritoneum is black and pyloric caeca are fewer than 10. Although Norman (1935, p. 102) emphatically considers "pelvic bones with slender posterior processes" as one of the characteristics of *Synodus,* he does not appear to have examined specimens belonging to each species of this genus. A detailed study on this problem is deferred to another paper.

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Table I. Measurements of *S. variegatus*

Locality	Tôkyô Bay.	Kôti	"	"	"	"	"	"
Sex	♀	♀	♂	♀	♀	♂	♂	—
Total length (mm)	257	265	—	251	—	—	159	118.5
Body length (mm)	218	230	214.5	211	186.5	179.0	133.5	98.3
Head in body length	3.43	3.48	3.64	3.42	3.39	3.58	3.30	3.25
Depth in body length	6.51	5.79	5.62	6.03	6.34	6.28	6.21	6.03
Width in body length	5.71	5.61	5.64	5.48	5.69	5.97	5.61	5.62
Depth of caudal peduncle in body length	17.44	17.16	16.89	17.15	18.28	17.05	15.17	16.38
Length of snout in body length	14.73	15.33	15.54	15.07	14.13	16.27	14.83	14.89
Width of snout in body length	13.63	13.37	13.84	13.61	12.69	14.92	13.62	12.29
Orbit in body length	26.59	26.14	25.54	25.73	25.90	23.25	23.02	19.66
Premaxillary in body length	5.49	5.71	5.80	5.51	5.37	5.59	5.13	4.96
Interorbital space in body length	25.95	25.84	26.81	27.40	26.64	28.41	31.79	32.77
Postorbital part of head in body length	5.08	5.02	5.46	5.05	5.14	5.31	4.89	5.09
Dist. from tip of snout to pectoral in body length	3.52	3.61	3.85	3.36	3.55	3.81	3.47	3.30
Dist. from tip of snout to ventral in body length	2.73	2.88	3.02	2.71	2.74	2.93	2.68	3.00
Dist. from tip of snout to first dorsal in body length	2.30	2.37	2.45	2.27	2.30	2.39	2.33	2.34
Dist. from tip of snout to adipose fin in body length	1.15	1.17	1.21	1.15	1.19	1.16	1.16	1.18
Dist. from tip of snout to anal in body length	1.20	1.22	1.25	1.21	1.22	1.23	1.21	1.23
Base of dorsal fin in body length	6.30	5.85	6.54	6.24	6.61	6.17	6.12	5.78
Base of anal fin in body length	11.53	10.95	10.46	10.55	11.10	11.93	11.13	10.92
Pectoral in body length	8.45	8.68	8.76	8.61	8.97	8.33	7.99	7.12
Ventral in body length	4.23	4.11	3.82	3.82	4.32	4.00	3.71	3.54
Longest dorsal fin ray in body length	7.27	7.30	7.10	7.15	7.23	6.63	6.85	6.03
Longest anal fin ray in body length	11.66	11.22	11.00	10.71	12.27	10.91	10.94	11.30

Table II. Frequencies of body proportions of *S. fuscus* (TANAKA)

Locality: Miya, Aiti Prefecture

Body length: II, 110~150 mm; III, 150~190 mm; IV, 190~230 mm, and V, 230~270 mm

Head in body length

3.50–3.60				3.60–3.70				3.70–3.80				3.80–3.90				3.90–4.00				4.00–4.10				4.10–4.20			
II	III	IV	V	II	III	IV	V	II	III	IV	V	II	III	IV	V	II	III	IV	V	II	III	IV	V	II	III	IV	V
1	1		1	3	4	3		10	9			5	7			3	3			2	4			1	1		

Depth in body length

7.40–7.80				7.80–8.20				8.20–8.60				8.60–9.00				9.00–4.40				9.40–9.80				9.80–9.90			
II	III	IV	V	II	III	IV	V	II	III	IV	V	II	III	IV	V	II	III	IV	V	II	III	IV	V	II	III	IV	V
1	1			2	6			6	13		1	7	8	2		6	1	1		2				1			

Width in body length

5.80–6.20				6.20–6.60				6.60–7.00				7.00–7.40				7.40–7.80				7.80–8.20				8.20–8.60			
II	III	IV	V	II	III	IV	V	II	III	IV	V	II	III	IV	V	II	III	IV	V	II	III	IV	V	II	III	IV	V
			1		1			4	5	2		5	13	1		9	7			7	2			1			

Depth of caudal peduncle in body length

19.0–20.0				20.0–21.0				21.0–22.0				22.0–23.0				23.0–24.0				24.0–25.0			
II	III	IV	V	II	III	IV	V	III	III	IV	V	II	III	IV	V	II	III	IV	V	II	III	IV	V
3			1	4	3			10	9			6	9	1		3	4	2		2	1		

Snout in body length

12.8–13.4				13.4–14.0				14.0–14.6				14.6–15.2				15.2–15.8				15.8–16.4				16.4–17.0				17.0–17.6			
II	III	IV	V	II	III	IV	V	II	III	IV	V	II	III	IV	V	II	III	IV	V	II	III	IV	V	II	III	IV	V	II	III	IV	V
1	1			2				5	7	1		9	6	1		5	9			2	4			3				1	1		

Width of snout in body length

12.5–13.0				13.0–13.5				13.5–14.0				14.0–14.5				14.5–15.0				15.0–15.5				15.5–16.0			
II	III	IV	V	II	III	IV	V	II	III	IV	V	II	III	IV	V	II	III	IV	V	II	III	IV	V	II	III	IV	V
	1				2		1	7	5		1	8	9		1	6	7			3	4			1	2		

Orbit in body length

19.0–20.0				20.0–21.0				21.0–22.0				22.0–23.0				23.0–24.0				24.0–25.0				25.0–26.0				26.0–27.0			
II	III	IV	V	II	III	IV	V	II	III	IV	V	II	III	IV	V	II	III	IV	V	II	III	IV	V	II	III	IV	V	II	III	IV	V
7				11	2			6	3			1	7			15				1	2			1				1		1	

Upper jaw in body length

5.6–5.8				5.8–6.0				6.0–6.2				6.2–6.4				6.4–6.6				6.6–6.8				6.8–7.0			
II	III	IV	V	II	III	IV	V	II	III	IV	V	II	III	IV	V	II	III	IV	V	II	III	IV	V	II	III	IV	V
1	2	1		4	4	1		10	7			5	8			2	4			2	5			2			

Interorbital space in body length

25.0–27.0				27.0–29.0				29.0–31.0				31.0–33.0				33.0–35.0				35.0–37.0				37.0–39.0				39.0–41.0				41.0–43.0			
II	III	IV	V	II	III	IV	V	II	III	IV	V	II	III	IV	V	II	III	IV	V	II	III	IV	V	II	III	IV	V	II	III	IV	V	II	III	IV	V
1	1			1				9	1			1	10	1		5	6			5	3			9				3				2			

Postorbital part of head in body length

5.4–5.6				5.6–5.8				5.8–6.0				6.0–6.2				6.2–6.4				6.4–6.6				6.6–6.8				6.8–7.0				7.0–7.2			
II	III	IV	V	II	III	IV	V	II	III	IV	V	II	III	IV	V	II	III	IV	V	II	III	IV	V	II	III	IV	V	II	III	IV	V	II	III	IV	V
	1			1	2	2		1	6	1		8	9			8	4			4	7			1	1			1				1			

Dist. from tip of snout to pectoral in body length

3.50–3.70				3.70–3.90				3.90–4.10				4.10–4.30				4.30–4.50			
II	III	IV	V	II	III	IV	V	II	III	IV	V	II	III	IV	V	II	III	IV	V
2	1	1		15	9	2		5	14			4	4				1		

Dist. from tip of snout to ventral in body length

2.60–2.70				2.70–2.80				2.80–2.90				2.90–3.00				3.00–3.10				3.10–3.20				3.20–3.30			
II	III	IV	V	II	III	IV	V	II	III	IV	V	II	III	IV	V	II	III	IV	V	II	III	IV	V	II	III	IV	V
			1	3	4	2		11	7	1		7	12			3	4				2			1			

Dist. from tip of snout to first dorsal in body length

2.20–2.25				2.25–2.30				2.30–2.35				2.35–2.40				2.40–2.45				2.45–2.50			
II	III	IV	V	II	III	IV	V	II	III	IV	V	II	III	IV	V	II	III	IV	V	II	III	IV	V
1		1		3	5	1	1	12	11	1		7	6			1	6			1	1		

Dist. from tip of snout to second dorsal in body length

1.17–1.20				1.20–1.23			
II	III	IV	V	II	III	IV	V
15	12	1	1	10	17	2	

Dist. from tip of snout to anal in body length

1.23–1.26				1.26–1.29			
II	III	IV	V	II	III	IV	V
15	19	3	1	10	10		

Base of dorsal fin in body length

7.2–7.5				7.5–7.8				7.8–8.1				8.1–8.4				8.4–8.7				8.7–9.0				9.0–9.3			
II	III	IV	V	II	III	IV	V	II	III	IV	V	II	III	IV	V	II	III	IV	V	II	III	IV	V	II	III	IV	V
4				4	8	1		6	9		1	3	6	2		5	2			1	3			2	1		

Base of anal fin in body length

9.6–10.0				10.0–10.4				10.4–10.8				10.8–11.2				11.2–11.6				11.6–12.0				12.0–12.4				12.4–12.8			
II	III	IV	V	II	III	IV	V	II	III	IV	V	II	III	IV	V	II	III	IV	V	II	III	IV	V	II	III	IV	V	II	III	IV	V
3	2			11	8			6	9			3	4	1		1	2		1	1	2		2						2		

Pectoral in body length

7.90–8.10				8.10–8.30				8.30–8.50				8.50–8.70				8.70–8.90				8.90–9.10				9.10–9.30			
II	III	IV	V	II	III	IV	V	II	III	IV	V	II	III	IV	V	II	III	IV	V	II	III	IV	V	II	III	IV	V
2				6	3			7	5	1		5	7	1		4	7			3				1	4	1	1

Ventral in body length

4.3–4.4	4.4–4.5	4.5–4.6	4.6–4.7	4.7–4.8	4.8–4.9	4.9–5.0	5.0–5.1	5.1–5.2
II III IV V	II III IV V	II III IV V	II III IV V	II III IV V	II III IV V	II III IV V	II III IV V	II III IV V
2	4	6 1	6 2	1 7 1	4 1 1 1	2 4	2	2 1

Longest dorsal fin ray in body length

6.3–6.5	6.5–6.7	6.7–6.9	6.9–7.1	7.1–7.3	7.3–7.5	7.5–7.7
II III IV V	II III IV V	II III IV V	II III IV V	II III IV V	II III IV V	II III IV V
2 2	9 6	8 9	4 7 1 1	2 5 1		1

Longest anal fin ray in body length

11.5–12.0	12.0–12.5	12.5–13.0	13.0–13.5	13.5–14.0	14.0–14.5	14.5–15.0	15.0–15.5
II III IV V	II III IV V	II III IV V	II III IV V	II III IV V	II III IV V	II III IV V	II III IV V
1	3 3	7 12 1	8 6 1	6 5 1	1	2	1

Table III. Measurements of *S. hoshinonis*

Locality	Kôti	Kôti	Kôti	Kôti
Sex	♂	♂	♂	♂
Total length (mm)	155	152	151	——
Body length (mm)	133	129	127	114.2
Head in body length	3.86	3.68	3.51	3.59
Depth in body length	7.60	8.06	7.43	8.04
Width in body length	6.89	6.97	6.51	7.01
Depth of caudal peduncle in body length	18.47	18.97	18.68	20.04
Length of snout in body length	16.22	15.18	14.94	15.43
Width of snout in body length	14.46	13.30	14.11	13.13
Orbit in body length	17.27	17.92	17.40	16.79
Premaxillary in body length	6.43	6.14	5.99	5.95
Interorbital space in body length	31.67	34.86	27.61	30.86
Postorbital part of head in body length	6.43	6.08	5.72	6.07
Dist. from tip of snout to pectoral in body length	3.96	3.77	3.85	3.65
Dist. from tip of snout to ventral in body length	2.94	2.85	3.02	2.79

Dist. from tip of snout to first dorsal in body length	2.49	2.44	2.35	2.47
Dist. from tip of snout to adipose fin in body length	1.20	1.17	1.18	1.20
Dist. from tip of snout to anal in body length	1.24	1.25	1.24	1.27
Base of dorsal fin in body length	6.43	6.23	6.41	6.34
Base of anal fin in body length	10.23	10.40	11.04	10.20
Pectoral in body length	8.06	8.06	8.30	8.46
Ventral in body length	4.43	4.37	4.54	4.36
Longest dorsal fin ray in body length	6.93	6.52	6.26	7.14
Longest anal fin ray in body length	13.17	12.06	12.70	12.83

Table IV. Frequencies of body proportions of *S. kaianus* (GÜNTHER)

Locality: Kumano-Nada, south-east to Kii Peninsula

Body length: I, 70~110 mm; II, 110~150 mm; III, 150~190 mm, and IV, 190~230 mm

Head in body length

3.5–3.6				3.6–3.7				3.7–3.8				3.8–3.9				3.9–4.0			
I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV
1		1	1	3	1	1		3	3	4	1	2		2					1

Depth in body length

6.1–6.5				6.5–6.9				6.9–7.3				7.3–7.7				7.7–8.1				8.1–8.5				8.5–8.9				8.9–9.3			
I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV
	2			1		1		1	3	1	2					1		4		2	1		1	2				2			

Width in body length

6.1–6.6				6.6–7.1				7.1–7.6				7.6–8.1				8.1–8.6				8.6–9.1				9.1–9.6				9.6–10.1				10.1 10.6			
I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV
	1				1	3		1		4	2	2	3				2				3		1										1		

Depth of caudal peduncle in body length

18.5–19.0	19.0–19.5	19.5–20.0	20.0–20.5	20.5–21.0	21.0–21.5	21.5–22.0	22.0–22.5	22.5–23.0
I II III IV	I II III IV	I II III IV	I II III IV	I II III IV	I II III IV	I II III IV	I II III IV	I II III IV
1	1 1 2	2 1	4 1 1	1 1 2	1 1	1 1	1	1

Snout in body length

10.6–11.0	11.0–11.4	11.4–11.8	11.8–12.2	12.2–12.6	12.6–13.0
I II III IV	I II III IV	I II III IV	I II III IV	I II III IV	I II III IV
3	4 1 1 1	1 1 2	1 2 2	2 1	1 1

Width of snout in body length

13.0–13.5	13.5–14.0	14.0–14.5	14.5–15.0	15.0–15.5	15.5–16.0	16.0–16.5	16.5–17.0
I II III IV	I II III IV	I II III IV	I II III IV	I II III IV	I II III IV	I II III IV	I II III IV
2	1 2	3 2	4 3	3 1	1 1		1

Orbit in body length

16.1–16.9	16.9–17.7	17.7–18.5	18.5–19.3	19.3–20.1	20.1–20.9	20.9–21.7	21.7–22.5
I II III IV	I II III IV	I II III IV	I II III IV	I II III IV	I II III IV	I II III IV	I II III IV
1	3 1	2 1 2	3 1 1	1 1	4	1	2

Upper jaw in body length

5.6–5.8	5.8–6.0	6.0–6.2	6.2–6.4	6.4–6.6
I II III IV	I II III IV	I II III IV	I II III IV	I II III IV
2	3 1 1 1	2 3 6	1	2 1 1

Interorbital space in body length

18.0–19.0	19.0–20.0	20.0–21.0	21.0–22.0	22.0–23.0	23.0–24.0
I II III IV	I II III IV	I II III IV	I II III IV	I II III IV	I II III IV
1	1	3 3 1	1 1 1	5 2 1	4

Postorbital part of head in body length

6.4–6.6				6.6–6.8				6.8–7.0				7.0–7.2				7.2–7.4				7.4–7.6				7.6–7.8				7.8–8.0			
I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV
			2			2	1			1	3			1	2	4	2	1		1				1				3			

Dist. from tip of snout to pectoral in body length

3.3–3.4				3.4–3.5				3.5–3.6				3.6–3.7				3.7–3.8				3.8–3.9				3.9–4.0			
I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV
1								2			1	3	2	2		1	2	2				4	1	2			1

Dist. from tip of snout to ventral in body length

2.5–2.6				2.6–2.7				2.7–2.8				2.8–2.9				2.9–3.0			
I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV
			1	5	1	2	1	3	3	3	1	1		1				2	

Dist. from tip of snout to first dorsal in body length

2.25–2.30				2.30–2.35				2.35–2.40				2.40–2.45				2.45–2.50			
I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV
3				1	1	2		2	3	2	2	3		3				1	1

Dist. from tip of snout to second dorsal in body length

1.15–1.18				1.18–1.21			
I	II	III	IV	I	II	III	IV
5	2	6	2	4	2	2	1

Dist. from tip of snout to anal in body length

1.21–1.24				1.24–1.27				1.27–1.30			
I	II	III	IV	I	II	III	IV	I	II	III	IV
		1	1	6	3	6	2	3	1	1	

Base of dorsal in body length

7.8–8.1				8.1–8.4				8.4–8.7				8.7–9.0				9.0–9.3				9.3–9.6				9.6–9.9			
I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV
2		1	2	2		3		3		2	1	2	1	1		1				2					1		

Base of anal in body length

9.6–10.0	10.0–10.4	10.4–10.8	10.8–11.2	11.2–11.6	11.6–12.0	12.0–12.4	12.4–12.8	12.8–13.2
I II III IV	I II III IV	I II III IV	I II III IV	I II III IV	I II III IV	I II III IV	I II III IV	I II III IV
2 1	1 1 1	3 1 2	2 1 1	1 2	1 1	1	1	1

Pectoral in body length

7.0–7.2	7.2–7.4	7.4–7.6	7.6–7.8	7.8–8.0	8.0–8.2	8.2–8.4	8.4–8.6
I II III IV	I II III IV	I II III IV	I II III IV	I II III IV	I II III IV	I II III IV	I II III IV
2 1	5 4 2	1 1 1	2	1 2 1			1

Ventral in body length

5.6–5.8	5.8–6.0	6.0–6.2	6.2–6.4	6.4–6.6	6.6–6.8	6.8–7.0	7.0–7.2
I II III IV	I II III IV	I II III IV	I II III IV	I II III IV	I II III IV	I II III IV	I II III IV
4 1	3 2	2 1 1	2 3 1	1	1	1	1

Longest dorsal ray in body length

7.3–7.5	7.5–7.7	7.7–7.9	7.9–8.1	8.1–8.3	8.3–8.5	8.5–8.7
I II III IV	I II III IV	I II III IV	I II III IV	I II III IV	I II III IV	I II III IV
2 2 1	4 1 4	2 1	1 1 1	1	2	1

Longest anal ray in body length

14.0–14.5	14.5–15.0	15.0–15.5	15.5–16.0	16.0–16.5	16.5–17.0	17.0–17.5	17.5–18.0	18.0–18.5
I II III IV	I II III IV	I II III IV	I II III IV	I II III IV	I II III IV	I II III IV	I II III IV	I II III IV
1	1 1	1	4 1 3	1 1 4	1 1	1 1		1

Table V. Frequencies of body proportions of

S. macrops (TANAKA)

Locality: Kumano-Nada, south-east to Kii Peninsula

(Abbreviations just the same as in Table IV)

Head in body length

3.8–3.9	3.9–4.0	4.0–4.1	41.–4.2
II III	II III	II III	II III
4	5	8 1	3 1

Depth in body length

69.–7.3	7.3–7.7	7.7–8.1	8.1–8.5	8.5–8.9	8.9–9.3
II III	II III	II III	II III	II III	II III
1	1	5	6 1	6 1	1

Width in body length

6.8–7.1		7.1–7.4		7.4–7.7		7.7–8.0		8.0–8.3		8.3–8.6	
I	II	I	II	I	II	I	II	I	II	I	II
1		11	1	5		2	1			1	

Depth of caudal peduncle in body length

19.0–19.5		19.5–20.0		20.0–20.5		20.5–21.0		21.0–21.5		21.5–22.0	
I	II	I	II	I	II	I	II	I	II	I	II
1		2	1	3		4		7		3	1

Snout in body length

15.1–15.5		15.5–15.9		15.9–16.3		16.3–16.7		167.–17.1		17.1–17.5	
I	II	I	II	I	II	I	II	I	II	I	II
1		6		3	1	4	1	4		2	

Width of snout in body length

13.0–13.5		13.5–14.0		14.0–14.5		14.5–15.0		15.0–15.5		15.5–16.0	
I	II	I	II	I	II	I	II	I	II	I	II
1		6		6	1	6			1	1	

Orbit in body length

14.5–15.0		15.0–15.5		15.5–16.0		16.0–16.5		1.65–17.0		17.0–17.5		17.5–18.0	
I	II	I	II	I	II	I	II	I	II	I	II	I	II
3		4		4	1	4		1		2	1	2	

Upper jaw in body length

6.5–6.7		6.7–6.9		6.9–7.1		7.1–7.3		7.3–7.5	
I	II	I	II	I	II	I	II	I	II
3		10		6		1	1		1

Interorbital space in body length

27.5–29.5		29.5–31.5		31.5–33.5		33.5–35.5		35.5–37.5		37.5–39.5	
I	III	I	III	I	III	I	III	I	III	I	III
2	1	4		8	1	3		2		1	

Postorbital part of head in body length

7.0–7.1		7.1–7.2		7.2–7.3		7.3–7.4		7.4–7.5		7.5–7.6		7.6–7.7		7.7–7.8		7.8–7.9	
I	III	I	III	I	III	I	III	I	III	I	III	I	III	I	III	I	III
1		1		3		4		6		2	1	2		1			1

Dist. from tip of snout to pectoral in body length

3.8–3.9		3.9–4.0		4.0–4.1		4.1–4.2		4.2–4.3		4.3–4.4	
I	III	I	III	I	III	I	III	I	III	I	III
1		3		5		10	1		1	1	

Dist. from tip of snout to ventral in body length

2.7–2.8		2.8–2.9		2.9–3.0		3.0–3.1		3.1–3.2	
I	III	I	III	I	III	I	III	I	III
1		5		8		5	2	1	

Dist. from tip of snout to first dorsal in body length

2.30–2.35		2.35–2.40		2.40–2.45		2.45–2.50		2.50–2.55		2.55–2.60	
I	III	I	III	I	III	I	III	I	III	I	III
1				7		7		3	2	2	

Dist. from tip of snout to second dorsal in body length

1.14–1.17		1.17–1.20		1.20–1.23	
I	III	I	III	I	III
2		14	1	4	1

Dist. from tip of snout to anal in body length

1.24–1.27		1.27–1.30	
I	III	I	III
9		11	2

Base of dorsal in body length

7.2–7.5		7.5–7.8		7.8–8.1		8.1–8.4		8.4–8.7		8.7–9.0		9.0–9.3	
I	III	I	III	I	III	I	III	I	III	I	III	I	III
3		1	1	7		5		1		2		1	1

Base of anal in body length

9.0–9.3		9.3–9.6		9.6–9.9		9.9–10.2		10.2–10.5		10.5–10.8		10.8–11.1	
I	III	I	III	I	III	I	III	I	III	I	III	I	III
4		2		1		3	1	6	1	3		1	

Pectoral in body length

7.5–7.7		7.7–7.9		7.9–8.1		8.1–8.3		8.3–8.5		8.5–8.7		8.7–8.9		8.9–9.1	
I	III	I	III	I	III	I	III	I	III	I	III	I	III	I	III
4		6		2	1	3	1			4				1	

Ventral in body length

4.8–5.0		5.0–5.2		5.2–5.4		5.4–5.6		5.6–5.8		5.8–6.0	
I	III	I	III	I	III	I	III	I	III	I	III
3		6		5		4	2	1		1	

Longest dorsal ray in body length

6.5–6.7		6.7–6.9		6.9–7.1		7.1–7.3		7.3–7.5		7.5–7.7		7.7–7.9	
I	III	I	III	I	III	I	III	I	III	I	III	I	III
4	1	5	1	5		3		1				2	

Longest anal ray in body length

13.5–14.0		14.0–14.5		14.5–15.0		15.0–15.5		15.5–16.0		16.0–16.5		16.5–17.0		17.0–17.5	
I	III	I	III	I	III	I	III	I	III	I	III	I	III	I	III
3		5	1	4	1			2		3		1		1	

Studies on the Deep-Sea Fishes of Japan, VI–VIII*

Kiyomatsu MATSUBARA

(Received Nov. 24, 1937)

VI. On Some Stomiatoid Fishes from Kumano Nada

A large number of specimens of stomiatoid fishes obtained from Kumano Nada, south-east to Kii Peninsula, at a depth of about 150 fathoms, have enabled the author to rewrite fully or annotate on five rare or imperfectly known species, to put on record one new species (*Melanostomias pauciradius*), to rank all the allied forms of *Yarrella blackfordi* as subspecies of it, and to describe one new subspecies (*Yarrella blackfordi elongata*).

The writer must express his sincere gratitude to Prof. A. TERAO for his kindness in supervising the present study. He offers his best thanks to Dr. S. TANAKA, Prof. T. KAMOHARA, Dr. I. TOMIYAMA and Mr. G. ABE, who helped him in various ways.

Fam. **Astronesthidae**

Astronesthes niger RICHARDSON

New Japanese name: *Kuro-tokagegisu*

Astronesthes niger RICHARDSON 1844, p. 97, pl. 50, figs. 1–3 (locality unknown, but supposed to be the China Seas).——GÜNTHER 1864, p. 425 (Gulf of Guinea, Lagos).——GÜNTHER, 1889, p. 38 (West Africa).——GOODE & BEAN, 1895, p. 105, fig. 123 (type of *Chauliodus fieldii* CUVIER & VALENCIENNES).——BRAUER, 1906, p. 29 (Gulf of Guinea)——PARR, 1927, p. 36 (Great Bahama Bank).——FOWLER, 1936, p. 216 (after GÜNTHER).

Stomias fieldii CUVIER & VALENCIENNES, 1846, p. 280 (between Mogador and New York).

Chauliodus fieldii CUVIER & VALENCIENNES, 1849, p. 290 (150 leagues southwest of Azores; St. Helena; between Mogador and New York).

Esox cirrhatus (FIELD) CUVIER & VALENCIENNES, 1846, p. 280.

Phaenodon ringens LOWE 1850, p. 251 (Madeira).

* Contributions from the Zoological Laboratory, Imperial Fisheries Institute, Tôkyô, No. 75. The expense of this work has been defrayed by the research fund from "Hattori Hôkô-kwai" (Hattori Gratitude Foundation).

D. 18; A. 14; p. 8; V. 7.

Head 3.95 in body length, measured to base of middle ray of caudal; depth 5.88; distance between tip of snout and origin of dorsal 2.0; same from origin of ventral to vent 3.44. Eye 4.58 in head; snout 4.40; upper jaw 1.29; barbel 1.44; interorbital width 3.67; postorbital part of head 1.73; depth of caudal peduncle 5.24; pectoral 1.36; longest dorsal ray (third one) 1.76; height of adipose fin 7.33; longest anal ray (third one) 3.23; ventral 1.29; caudal 1.40.

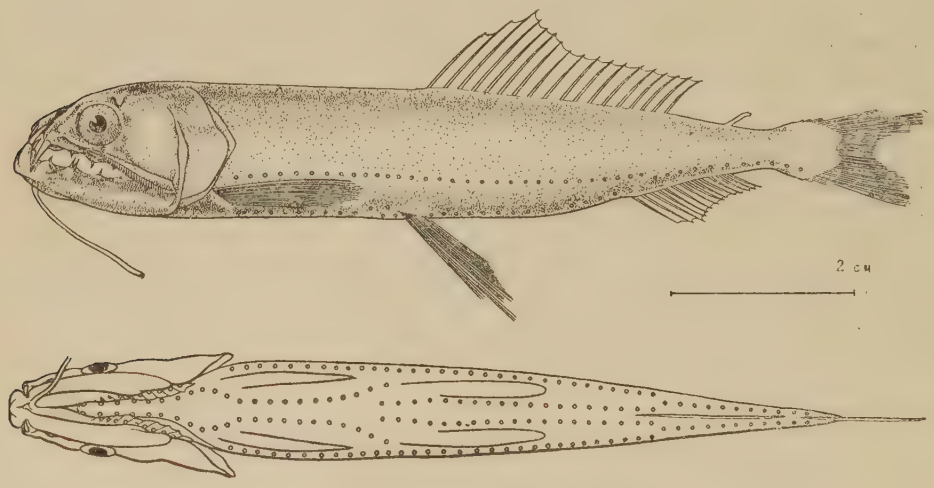

Fig. 1. *Astronesthes niger* RICHARDSON

Body rather elongate. Lower jaw heavy, somewhat projecting beyond the upper when mouth is closed. Teeth 5 on left side, 4 on right side, of premaxillary, 11 on left side, 10 on right side, of lower jaw, the second one on each side fang-like, much larger than the others; teeth of maxillary gradually becoming larger posteriorly, closely set in a comb-like fashion. Barbel not swollen at tip, shorter than head, somewhat past the posterior margin of preopercle. Interorbital space wide, and slightly convex. Top of head rather rough; a large and broad postorbital spine present, directed downward.

Photophores small and numerous, located either separately or serially: at the middle of lower edge of eye and at the center of operculum one each; from origin of pectoral to above initial part of anal there extends a lateral series of 31 photophores, of which first 13 between origin of pectoral and that of ventral, next 17 behind origin of

ventral to that of anal, and the last one above initial part of anal; a ventral series of 53 photophores stretches from isthmus to caudal, first 11 from isthmus to origin of pectoral, second 11 behind origin of pectoral to that of ventral, third 17 from front of ventral to origin of anal, and last 14 from origin of anal to caudal.

Dorsal begins behind origin of ventral and just midway between tip of snout and base of caudal. Small adipose fin above end of anal. Anal commences under last dorsal ray but three. Body jet black.

Described and figured from a specimen, Imp. Fish. Inst. Fish Sp. No. 4243, measuring 99.8 mm long (body length 87 mm).

Both the above-mentioned specimen and a much mutilated one stand at variance with RICHARDSON'S description of *Astronesthes niger* in having somewhat larger number of dorsal (14 to 18 in the latter), fewer pectoral (9 in the latter), slenderer body (depth of body 5.50 in body length in the latter), and in lacking the luminous patch on shoulder. And yet agreement with it in other important characters is so obvious as to warrant one to refer them to the present species which is new to the fauna of Japan.

Fam. **Melanostomiatidae**

Melanostomias pauciradius, sp. nov.

New Japanese name: *Kanten-tokagegisu*

D. 13; A. 17; P. 3; V. 7.

Head 7.28 in body length, measured to base of middle caudal ray; depth at pectoral 8.22, and at belly 7.28; distance between tip of snout and origin of dorsal 1.20; distance from origin of pectoral to vent 1.21.

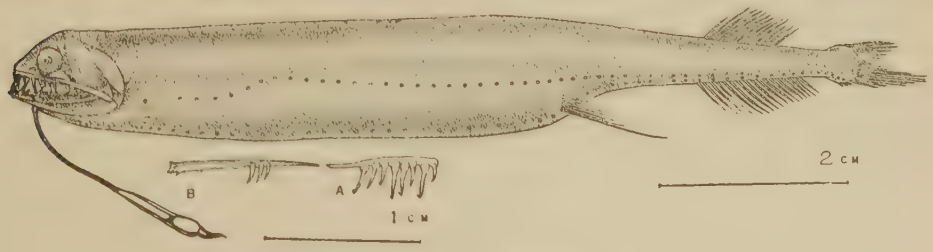

Fig. 2. *Melanostomias pauciradius* sp. nov.
A, premaxillary of right side;
B, maxillary of the same side

Eye 4.52 in head; snout 5.30; upper jaw 1.09; interorbital space 3.81; postorbital part of head 1.58; depth of caudal peduncle 5.30; pectoral 2.44; ventral 1.02; longest dorsal ray (fifth one) 2.22; longest anal ray (seventh one) 2.35; caudal 1.22.

Body elongate; head very short, as long as the depth of body at belly. Jaws equal, mouth cleft somewhat oblique, exceedingly large, maxillary reaching preopercular ridge. Teeth large and uneven: 9 teeth on left side, 8 on right side, of premaxillary with third, fifth and ninth ones of the former and second, fourth, fifth and eighth ones of the latter much larger, somewhat fang-like; 3 moderate teeth in the anterior part of each maxillary; 8 teeth in each mandibular ramus, with third and fifth much larger and fang-like; 1 depressible vomerine, and 4 palatine teeth present on each side; 2 pairs of fine recurved teeth on tongue. Barbel somewhat longer than twice the length of head, yellowish white except blackish basal half of it, provided near its filamentous end with an elliptical cream-yellowish luminous body, edged anteriorly and posteriorly with small black blotches. Interorbital space flat.

A posteriorly more acutely pointed triangular luminous body present, nearly as long as eye, closely above maxillary and below hind edge of eye; none seems to be present on face. Photophores of upper lateral series 42, of which first 27 between origin of pectoral and that of ventral, second 11 before anal, and last 4 above anal base; photophores of lower or ventral series 64, of which 8 on isthmus, 1 before pectoral, 29 between origin of pectoral and that of ventral, 11 before anal, and 15 running to base of caudal.

Dorsal and anal with thin membrane, situated posteriorly, opposite with each other; caudal well forked; ventral rather long, but not reaching the vent.

Body black; teeth and luminous body behind eye whitish.

Described and figured from a specimen, Imp. Fish. Inst. Fish Sp. No. 1812, measuring 98 mm long (body length 88.8 mm).

Differs from the allied species principally in having fewer pectoral rays.

Fam. **Gonostomidae**

Neostoma gracile (Günther)

Japanese name: *Yoko-eso*

Gonostoma gracile Günther, 1878, p. 187.——Günther, 1887, p. 174, pl. 74, fig. c (south of Japan).
Neostoma gracile Jordan & Starks, 1904, p. 579 (surface of Suruga Bay).

D. 12; A. 28; p. 9; V. 7.

Head 5.62 in body length measured to base of middle ray of caudal; depth 9.45. Eye 6.61 in head; snout 6.17; interorbital space 4.40; upper jaw 1.14; pectoral 1.68; ventral 2.13; caudal 1.37. Vent somewhat more proximal to snout than to base of caudal.

Fig. 3. *Neostoma gracile* (Günther)

Two rows of photophores run on lower half of body: the lower series comprises 5 small ones in front of pectoral, 5 larger ones between pectoral and ventral, 2 smaller ones between ventral and anal, and 14 between origin of anal and base of caudal; the upper series consists of 3 between base of pectoral and that of ventral (of which the anteriormost one much smaller), 2 between ventral and anal, 5 smaller ones above the base of anal, and 1 at base of middle of caudal ray. Besides these, 2 small ones behind the gill-opening, 1 near the back and above the middle of the distance between base of pectoral and that of ventral, 1 below and slightly before the origin of dorsal and 1 below and behind the end of base of dorsal; 2 oblong glandular masses present on lower side of base of caudal fin, but absent on the corresponding upper side of caudal; a similar large mass below eye and a small spot before it. No photophore behind the middle of the hind margin of preopercle.

As described above, a single specimen at my disposal, (Imp. Fish. Inst. Fish Sp. No. 4242), measuring 116.2 mm in total length (104.0 mm in body length), is discrepant from Günther's account of *Gonostoma gracile* in some points, especially in the number and arrangement of

photophores, although obviously referable to the present species.

Yarrella blackfordi illustris (McCULLOCH)

New Japanese name: *Gin-hadaka*

Polymetme illustris McCULLOCH, 1926, p. 161 (Great Australian Bight; south of Gabo Island, Victoria).

? *Yarrella blackfordi* (pars) (not of GOODE & BEAN, 1895) NORMAN, 1930, p. 288.

? *Yarrella corythaeola* (pars) (not *Diplophos corythaeolum* ALCOCK, 1898) NORMAN, 1930, p. 289.

Yarrella corythaeola KAMOHARA, 1936, p. 17 (off Kôti).

D. 11 or 12; A. 28 to 31; p. 9 to 11; V. 7.

Head 4.28 to 4.53 in body length, measured to base of middle ray of caudal; depth 4.92 to 6.31; eye 18.83 to 21.46; snout 17.60 to 18. 89; interorbital space 18.92 to 26.73; upper jaw 5.58 to 5.83. Gill-rakers on first arch 5~6+9~11, the longest one scarcely shorter than diameter of eye.

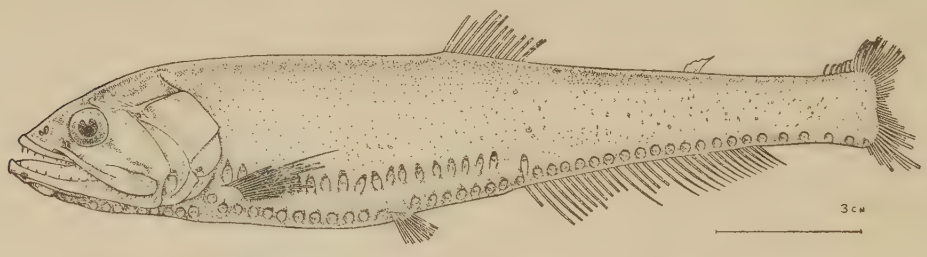

Fig. 4. *Yarrella blackfordi illustris* McCULLOCH

Upper series of photophores on sides of body always 17, extending between above base of pectoral and before origin of anal; 9 or rarely 10 photophores on branchiostegal membrane; a pair on mandibular symphysis; decidedly 21 from tip of isthmus to before origin of ventral, of which 9 on isthmus and 1 before the base of pectoral; 8 (rarely 7) between ventral and before origin of anal; 15 or 16 above base of anal, the first of which vertically elongated; 6 or 7 on caudal peduncle; a distinct photophore on preorbital, top of opercle, lower end of preopercle and lower angle of subopercle.

Described from 14 specimens measuring 132 to 198 mm in body length and the accompanying figure is drawn from a female specimen, Imp. Fish. Inst. Fish Sp. No. 1926, measuring 176 mm in body length; their measurements are given in the following table:

Sex	♀	♀?	♀	♀	♀	♂	♀	♀	♀	♂	♂	♂	♂	♂
BL (mm)	176.0	139.0	132.0	198.0	194.0	187.0	175.0	169.0	163.0	159.5	148.8	145.0	142.8	140.0
DO	11	12	11	11	11	12	11	12	11	11	11	11	11	11
A	29	29	30	28	29	30	30	30	30	29	29	30	31	30
P	10	11	10	10	10	10	10	10	10	10	9	10	11	10
V	7	7	7	7	7	7	7	7	7	7	7	7	7	7
GR	6+10	6+10	5+11	6+10	6+10	6+10	6+10	6+10	6+10	6+10	6+9	6+11	6+10	6+10
H in BL	4.28	4.41	4.40	4.40	4.31	4.47	4.49	4.45	4.53	4.46	4.38	4.39	4.46	4.38
D in BL	4.92	5.35	6.17	5.08	5.32	6.01	5.74	5.45	5.40	5.72	6.25	6.30	5.53	6.31
E in BL	21.46	19.31	18.86	20.00	20.86	19.08	21.34	20.61	19.88	19.45	19.84	18.83	19.56	18.67
S in BL	17.60	18.29	18.33	17.68	18.83	18.89	17.86	18.17	18.11	18.76	18.15	18.59	17.85	18.67
M in BL	5.83	5.58	5.62	5.58	5.71	5.83	5.83	5.81	5.78	5.70	5.72	5.80	5.71	5.76
IS in BL	18.92	26.73	23.16	22.00	21.56	12.49	22.44	21.39	22.96	22.79	22.89	24.17	24.62	23.33
Ph. SL	17	17	17	17	17	17	17	17	17	17	17	17	17	17
Ph. M	10	9	9	9	9	9	9	9	9	9	9	9	9	9
Ph. IT	21	21	21	21	21	21	21	21	21	21	21	21	21	21
Ph. V	8	8	8	8	8	8	8	8	8	8	8	8	8	7
Ph. A	16	16	15	16	16	16	16	16	16	16	15	16	16	16
Ph. C	6	6	7	7	6	7	6	6	6	6	6	6	6	7

Table 1. Measurements of *Y. blackfordi illustris* (McCulloch) (BL, body length measurd to base of middle ray of caudal; Do, dorsal rays; A, anal rays; P, pectoral rays; V, ventral rays; GR, gill-rakers; H, head; D, depth; E, eye; S, snout; M, upper jaw; IS, interorbital space; Ph. SL, photophores of upper series of body between above base of pectoral and before origin of anal; Ph. M, same on branchiostegal membrane; Ph. IT, same from tip of isthmus to before origin of ventral; Ph. V, same from behind origin of ventral to insertion of anal fin; Ph. A, same above base of anal fin; Ph. C, same on caudal peduncle.) (The last 11 specimens were procured from off Kôti by Prof. Kamohara.)

The present fish was described in 1926 as a new genus and new species, *Polymetme illustris*, by McCULLOCH, but apparently the genus *Polymetme* is a synonym of *Yarrella* ALCOCK 1895. My careful examination, however, has shown that not only *Polymetme illustris* of McCULLOCH but also all other species belonging to the genus *Yarrella* are not fully differentiated from each other and each should go as a subspecies of *Yarrella blackfordi* GOODE & BEAN.

To quote examples, the specimens I observed quite agree with the figure and description of McCULLOCH's *Polymetme illustris* except in having 15 or 16 photophores (17 in the latter) along the base of anal fin and 6 or 7 (5 in the latter) on caudal peduncle.

Yarrella blackfordi of NORMAN seems to differ from that of GOODE & BEAN at least in having 10 to 12 dorsal rays (15 in the latter) and includes under it two other forms: one with a larger number of anal rays and agreeing with the present fish, and the other with a fewer number of anal rays and identical with the figure and description of GILCHRIST & VON BONDES' *Yarrella africana*.*

Yarrella corythaeola of NORMAN was described from two specimens; one was afterwards used as the type of *Diplophos corythaeolum* ALCOCK and the other was regarded as a paratype of *Polymetme illustris*

* The following is the original description of *Yarrella africana* given by GILCHRIST & VON BONDE:

D. 11; A. 25; V. 8; P. 10; depth of body 6 in length; head 4.8; eye 4.5 in head.

Body elongate, somewhat compressed laterally; head moderate, snout equal to diameter of eye; maxillary reaches far behind eye, its length being 1.5 times postorbital length of head; mouth very wide, oblique, lower jaw projecting strongly; teeth small and in a single row on maxillary; eye situated at end of anterior half of head; origin of dorsal midway between tip of snout and base of caudal and over middle of space between ventrals and anal; its posterior ray lies just behind beginning of anal; rays imperfect; distance of origin of ventral from tip of snout contained 2.5 in length of body; ventrals small; pectorals placed low down on body, base narrow, length of fin 1.3 in head; caudal damaged but apparently moderately forked.

Phosphorescent organs: Nine on isthmus: twenty between symphysis of mandible and root of ventral; seven between origin of ventral and anus; twenty-four from anus to base of caudal; a second row of 18 spots from above base of pectoral to origin of anal.

Length of largest specimen: 180 mm.

Localities:

Consecutive No.	Station No.	Depth.
888	104	226 fms.
1521	160	240 "
2547	263	220 "
3455	375	201 "

McCulloch, the difference between the two being 24 or 25 in the number of anal rays in the former and 28 to 33 in that of the latter.

Yarrella blackfordi elongata, subsp. nov.

New Japanese name: *Ryûgû-hadaka*

D. 12; A. 32; P. 10; V. 7.

Head 5.43 in body length measured to base of middle ray of caudal; depth 6.80; distance from tip of snout to origin of dorsal 2.03; between tip of snout and origin of ventral 2.56; from tip of snout to origin of anal 1.80. Eye 4.63 in head (25.17 in body length); snout 4.03 (21.88 in body length); upper jaw 1.36 (7.37 in body length); interorbital space 3.97; depth of caudal peduncle 2.84; postorbital part of head 1.88. Gill-rakers on first arch 8+12, the longest one as long as eye.

Body elongate; head shorter than one-fifth the length of body. Eye rather large, somewhat shorter than snout. Lower jaw projecting beyond the upper when mouth is closed. Teeth on premaxillary and mandible small and feeble, arranged irregularly and sparsely in a double row; those on maxillary larger, in a single row; a row of small teeth on palatines; two somewhat larger ones on either head of vomer.

Fig. 5. *Yarrella blackfordi elongata,* subsp. nov.

Upper series of photophores on sides of body consist of 17, begining above base of pectoral and ending above vent; 9 photophores on branchiostegal membrane; 1 on each side of mandibular symphysis; 21 between tip of isthmus and origin of ventral, of which 9 on isthmus and 1 before base of pectoral and 11 behind origin of pectoral to ventral; 8 between ventral and before origin of anal; 17 above base of anal, the first of

which elevated to the same level of upper series of photophores; 7 on caudal peduncle. Preorbital, top of opercle, lower end of preopercle and lower angle of subopercle each provided with a distinct photophore.

Origin of dorsal about midway between tip of snout and base of caudal; anal inserted below antepenult dorsal ray.

Color in formalin dark brown above, paler on sides, the junction of two colors sharply defined; underside of body again dark brown. Opercle and upper half of subopercle dark gray.

Described and figured from a female specimen, Imp. Fish. Inst. Fish Sp. No. 1963, measuring 151 mm in body length.

The measurements of other 15 specimens are shown in Table 2.

It should be mentioned that the origin of anal fin shows rather remarkable individual variations; of 16 specimens I observed, 1 begining under last dorsal ray but five, 3 under last one but four, 4 under last one but three, 2 under antepenult, 4 under penultimate one, and 2 just below the end of base of dorsal fin.

The present new subspecies possesses smaller head, lower depth of body, shorter upper jaw, shorter snout and smaller eye than *Y. black-*

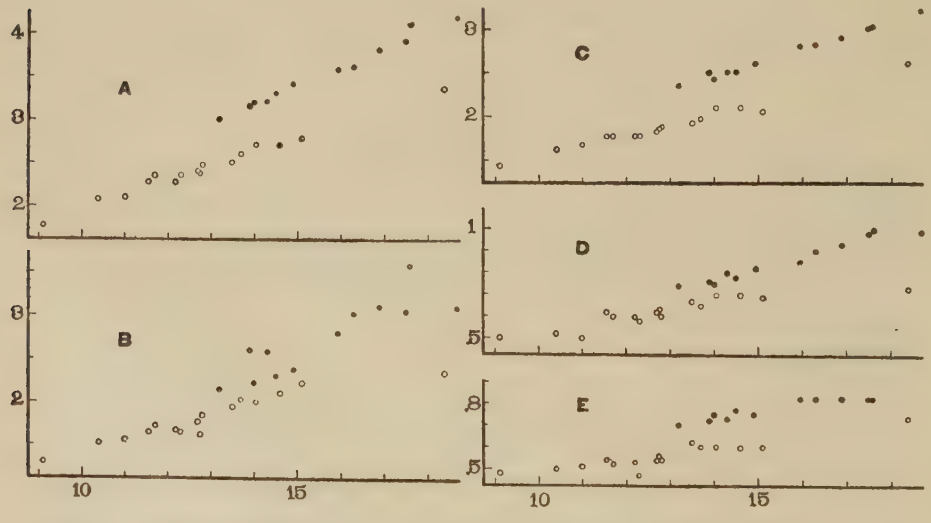

Fig. 6. Showing dimension (in cm) of body parts in relation to body length of *Y. blackfordi illustris* and *Y. blackfordi elongata*.
●, *Y. blackfordi illustris*; ○, *Y. blackfordi elongata*. A, length of head; B, depth of body; C, length of upper jaw; D, length of snout; E, length of eye.

Sex	♂	♀	♀?	♂	♂	♂	♂?	♂?	♀	♂?	♀	?	♂	♂	♂
BL (mm).....	184.0	146.0	140.5	137.0	135.2	128.0	127.5	127.0	123.0	122.0	117.0	115.5	110.0	104.0	91.0
DO	11	12	12	11	12	13	11	12	13	13	12	12	11	12	11
A	30	30	31	32	33	31	30	28	31	30	29	29	29	30	?
P	10	10	10	10	10	9	10	10	11	10	11	10	10	10	10
V	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7
GR	7+11	7+11	7+11	7+11	7+11	7+11	7+11	7+11	7+11	7+11	8+11	7+11	7+11	7+11	7+11
H in BL.....	5.49	5.41	5.20	5.20	5.37	5.16	5.36	5.29	5.24	5.35	4.98	5.07	5.24	5.00	5.11
D in BL.....	7.83	6.95	7.03	6.78	6.93	6.92	7.82	7.13	7.45	7.26	6.80	7.00	7.10	6.80	7.00
E in BL.....	25.21	24.33	23.42	22.83	21.81	23.70	22.77	23.52	26.17	23.02	22.50	21.40	22.00	20.80	18.96
S in BL.....	20.67	20.86	20.07	21.08	20.18	21.33	20.24	20.48	21.21	20.33	19.50	18.63	22.00	20.00	18.20
M in BL.....	7.08	6.95	6.69	6.92	7.04	6.81	6.89	6.98	6.91	6.85	6.57	6.49	6.55	6.42	6.36
IS in BL.....	23.90	24.75	22.30	24.04	27.04	25.60	26.56	27.02	26.17	24.40	24.38	25.11	24.44	24.19	23.95
Ph. SL.....	17	17	17	17	17	17	18	17	17	17	17	17	17	17	17
Ph. M	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9
Ph. IT	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21
Ph. V	8	8	8	8	8	8	9	8	8	8	8	8	8	8	8
Ph. A	17	17	17	17	17	17	16	16	17	17	16	17	17	17	17
Ph. C	6	6	6	6	6	6	6	7	6	6	7	6	6	6	6

Table 2. Measurements of *Y. blackfordi elongata*, subsp. nov.
(Abbreviations are just the same as in Table I.)

fordi illustris (See Figs. 4 to 6 and Table I and II), and, may be distinguished from all the hitherto known forms of the genus *Yarrella* as given in the following artificial key:

a Dorsal rays 15; 12 photophores between ventral and anal; eye very small, about 7 in head. Atlantic ..... *Y. blackfordi blackfordi* GOODE & BEAN (1895)

a' Dorsal rays 11 to 13; 7 or 8 photophores between ventral and anal; eye larger, 4 to 5 in head.

b Anal rays 23 or 25.

c Length of head about 4 in body length. Andaman Sea ..... *Y. blackfordi corythaeola* ALCOCK (1899)

c' Length of head 4.8 to 5 in body length. Natal coast; Atlantic ..... *Y. blackfordi africana* (GILCHRIST & VON BONDE) (1924)

b' Anal rays 28 to 33.

d Length of head 4.2 to 4.3 in body length; upper jaw 5.58 to 5.83. Australia; Atlantic; off Kôti; Kumano Nada ..... *Y. blackfordi illustris* (MCCULLOCH) (1926)

d' Length of head 5.0 to 5.4 in body length; upper jaw 6.55 to 7.08. Off Kôti; Kumano Nada ..... *Y. blackfordi elongata*, subsp. nov.

Fam. **Idiacanthidae**

Idiacanthus fasciola PETERS

New Japanese name: *Mitsumata-yariuwo*

Idiacanthus fasciola PETERS, 1876, Monatsber. Akad. Berlin, p. 847 (north of Austraria and north of New Guinea.——GOODE & BEAN, 1895, p. 128 (from types).——BRAUER, 1906, p. 60, figs. 17~20, pl. 4, figs 2~3 (off Sumatra; between Chagos and Seychelles Islands; west of Chagos).——WEBER, 1913. p. 15 (Manipa Strait and Halmahera Sea).——WEBER & BEAUFORT, 1913, p. 108, fig. 37——PARR, 1927, p. 116, fig. 62 (Bermuda and Bahamas).——FOWLER, 1928, p. 34.——BEEBE, 1929, p. 13 (Hudson Gorge).——REGAN & TREWAVAS, 1930, p. 129 (from type of *Idiacanthus ferox*).——ROULE & ANGEL, 1933, p. 24 (eastern Atlantic).——BEEBE, 1933, p. 39 (Bermuda).——BEEBE, 1934, p. 149~241, figs. 47~81 (Bermuda).——FOWLER, 1936, p. 218 (after WEBER & BEAUFORT).

Bathyophis ferox GÜNTHER, 1878, p. 181 (middle of North Atlantic).

Idiacanthus ferox GÜNTHER, 1887, p. 216, pl. 52, fig. D (from type).——GOODE & BEAN, 1895, p. 129, fig. 151 (from type).——JORDAN & EVERMANN, 1896, p. 605 (from type).——BARNARD, 1925, p. 136 (South African Seas).——FOWLER, 1936, p. 218 (after GÜNTHER).

D. 60; A. 35; V. 6.

Head 15.18 in body length, measured to base of middle ray of caudal; depth 29.50; distance from tip of snout to origin of dorsal 2.89; from tip of snout to origin of ventral 2.62; between origin of

ventral to that of anal 3.06; distance from origin of anal to tip of caudal 3.18; barbel 8.90. Eye 6.80 in head; snout 4.00; upper jaw 1.00; interorbital width 3.78; depth of caudal peduncle 8.50, postorbital part of head 1.60; ventral 1.06. Barbel 1.74 times of head, larger branch at its tip very blunt, and not elongated. Pelvics inserted below between fourth and fifth dorsal rays, their distance from anal 0.85 times as long as that between tip of snout and origin of ventral, and about as long as the distance from origin of anal to tip of caudal. Photophores 29 from isthmus to before origin of ventral, 22 from origin of ventral to before origin of anal and 21 from origin of anal to base of caudal. Three longitudinal series of white patches run along body.

Described and figured from a single female specimen, Imp. Fish. Inst. Fish Sp. No. 4513, measuring 422 mm long (413 mm from tip of snout to base of middle caudal ray).

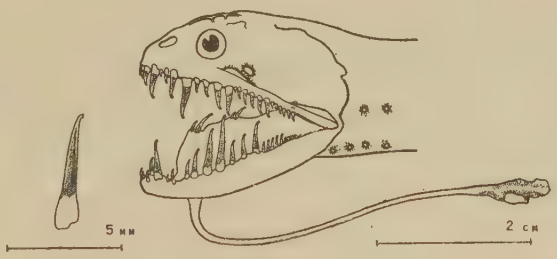

Fig. 7. *Idiacanthus fasciola* PETERS
Fig. 8. Head of *Idiacanthus fasciola* PETERS

My single specimen stands intermediate in some important characters between *Idiacanthus fasciola* PETERS and *I. panamensis* REGAN though I identified my specimen with the former with some doubt.

The specimen mentioned above differs from *Idiacanthus fasciola* described by various authors in having 22 photophores between origin of ventral and that of anal (15 to 18 in *I. fasciola* and 16 to 22 in *I. panamensis* of REGAN) and also from *Idiacanthus panamensis* of REGAN in having rather anterior insertion of pelvics (in *I.*

panamensis, pelvics begin under fourth to ninth dorsal ray and most of them uuder sixth or seventh dorsal ray, but in *I. fasciola* under first to eighth dorsal ray and mostly under second to fifth dorsal ray), but agrees with them in other characters.

Maurolicidae

Maurolicus japonicus ISHIKAWA

Japanese name: *Kyûri-eso*

Maurolicus japonicus ISHIKAWA, 1915, p. 183, pls. 12~13 (Uodu).
Maurolicus pennanti (not *Argentina pennanti* of WALBAUM 1792) JORDAN & HUBBS, 1925, p. 154 (Toyama).——TANAKA, 1931, p. 49.

Single specimen was obtained, measuring 36 mm in body length, Imp. Fish. Inst. Fish Sp. No. 4255, and is included in every character within the range of variations of *Maurolicus japonicus* ISHIKAWA, which was fully described and figured from many specimens. The present species differs from the Atlantic species, *Maurolicus pennanti* (WALBAUM) in having 8~9 postero-anal photophores (8 in my specimens) instead of 2~3 in the latter, longer caudal peduncle and the ventral inserted just before the dorsal, but not below it as is the case with the latter, though JORDAN and HUBBS and also TANAKA united this species with *Maurolicus pennanti* (WALBAUM) without giving any reason for this amalgamation.

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VII. On Some Rare or Imperfectly known Lantern-fishes Found in Kumano-Nada.

Most of the lantern-fishes found in Kumano Nada, south-east to Kii Peninsula, are represented by two species, viz., *Neoscopelus macrolepidotus* JOHNSON and *Diaphus coeruleus* (KLUNZINGER), but seven species described here, including one belonging to the family *Paralepidae*, are rather rare and some of them are erroneously or imperfectly known.

The writer is greatly indebted to Prof. A. TERAO, under whose supervision the present study was carried out and to Dr. S. TANAKA, Prof. T. KAMOHARA, Dr. I. TOMIYAMA and Mr. G. ABE, who helped him in various ways.

Fam. **Myctophidae**

Myctophum fibulatum Gilbert & Cramer

New Japanese name: *Hokuto-hadaka*

Myctophum fibulatum Gilbert & Cramer, 1896, p. 411, pl. 38, fig. 2 (Hawaii).——Gilbert, 1905, p. 595 (Hawaii).——Jordad & Jordan, 1922, p. 11 (Hawaii).
Myctophum (*Myctophum*) *pterotum* (pars) Brauer, 1906, p. 182, fig. 93.
Myctophum pterotum Fowler, 1928, p. 70.

A single female specimen was obtained, measuring 102 mm long (82 mm in body length to base of middle caudal ray), Imp. Fish. Inst. Fish Sp. No. 1911., and generally agrees well with description and figure of Gilbert & Cramer's *Myctophum fibulatum* and fig. 93 of

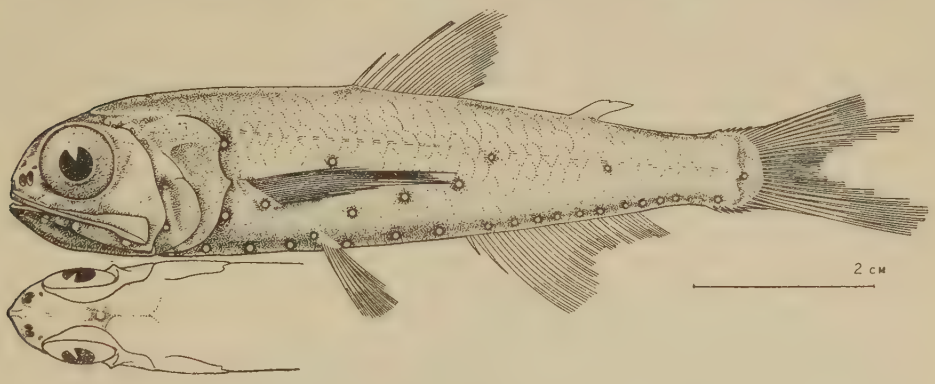

Fig. 9. *Myctophum fibulatum* Gilbert & Cramer

Brauer's *Myctophum* (*Myctophum*) *pterotum*, except that the photophores of postero-anals are 4 instead of 5. I would like to call attention to the point that Brauer's fig. 94 represents a species quite distinct from the present one. It may be mentioned that a small black-ringed photophore is present on the anterior orbital rim. The present species is new to the fauna of Japan.

Lampanyctus resplendens Richardson

Japanese name: *Ôkuti-iwashi*

Lampanyctus resplendens Richardson, 1844~1848 (before March 1, 1845), p. 42, pl. 27, figs. 16~18 (Gulf of Guinea).——Fowler 1936, p. 386, fig. 186 (after Brauer's *Myctophum* (*Lampanyctus*) *elongatum*).
Scopelus resplendens Günther, 1864, p. 415 (Gulf of Guinea).
Scopelus elongatus Costa, 1846, p. 2, pl. 38 (Ercolano).

Myctophum (*Lampanyctus*) *elongatum* BRAUER, 1906, p. 232. figs. 152~153 (Gulf of Guinea and west of Cape colony).

?*Notoscopelus quercinus* GOODE & BEAN, 1895, p. 83, pl. 26, fig. 97.

?*Macrostoma quercinum japonicum* TANAKA, 1908, p. 5, pl. 1, fig. 3 (Misaki).

?*Macrostoma japonicum* TANAKA, 1911, p. 59 (from type).

?*Lampanyctus japonicus* GILBERT, 1913, p. 99 (from TANAKA's *Macrostoma quercinum japonicum*).

D. 21 or 22; A. 19; pored scales of lateral line 40 to 44; gill-rakers on first arch 8~9+16~17.

Head 3.89 to 4.26 in body length; depth 6.06 to 6.33; distance from tip of snout to origin of dorsal 2.48 to 2.57; between tip of snout to origin of ventral 2.51 to 2.52; from tip of snout to origin of anal 1.79 to 1.80; from tip of snout to end of base of anal 1.30 to 1.32; length of base of dorsal 3.64 to 3.80; length of base of anal 4.64 to 5.00. Eye 4.54 to 4.59 in head; snout 6.71 to 7.61; upper jaw 1.30 to 1.41; interorbital width 3.46 to 3.49; depth of caudal peduncle 2.84 to 2.97; pectoral 2.24 to 2.58; ventral 1.82 to 1.87. Longest gill-raker on first arch 1.13 to 1.31 in diameter of orbit.

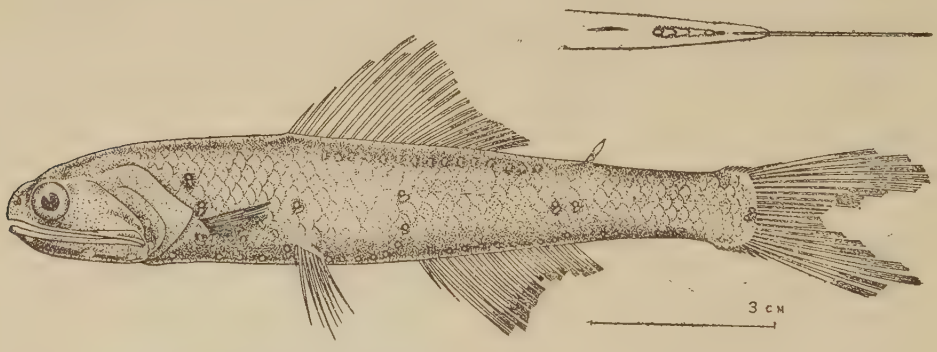

Fig. 10. *Lampanyctus resplendens* RICHARDSON

Photophores: a small pre-orbital one on orbital margin immediately above level of nostril; 3 on branchiostegal membrane and 1 behind angle of preoperculum and 1 below it; no spot on shoulder; supra-pectoral near the lateral line; upper infra-pectoral distinctly vertical above the base of pectoral and lower infra-pectoral just below base of pectoral; thoracics 5, the last one of them elevated, distance between first and second ones twice as long as the distance between second and third ones; supra-ventral directly above base of ventral, somewhat nearer lateral line than ventral; ventrals 5, the hindmost of them

slightly elevated; supra-anals 3, somewhat angulated, the middle one vertically below the upper one, the lower one above and posterior to the fifth of ventrals; antero-anals 9; postero-anals 7; postero-laterals 2, equally high and close together; pre-caudals 4, the anterior 2 on the same level; upper supra-anal, postero-laterals and upper pre-caudal immediately beneath the lateral line.

Luminous scales: a large luminous scale present just below each of infra-pectoral, supra-pectoral, supra-ventral, upper and middle supra-anal, postero-lateral and upper pre-caudal photophore; 5 smaller ones below pectoral fin; about 15 larger ones arranged in a longitudinal series below first dorsal; and 6 distinct ones on back of caudal peduncle.

The above description is based upon 3 specimens, measuring 123 to 136.6 mm in body length and the accompanying figure is drawn from a male specimen, 153 mm in body length, Imp. Fish. Inst. Fish Sp. No. 1872.

The specimens I observed have lower body, smaller eye, longer snout and somewhat shorter pectoral than FOWLER's *Lampanyctus resplendens* (depth 5 in body length; eye $3\frac{2}{3}$ to $4\frac{1}{2}$ in head; snout 2 in eye in the latter), but quite agree with it in other important characters. GOODE & BEAN's *Notoscopelus quercinus* generally agrees with my specimens in various characters. The specimens at my disposal have somewhat shorter snout, smaller eye, higher body and somewhat larger number of gill-rakers on first gill-arch than TANAKA's *Macrostoma quercinum japonicum*; and also they do not agree with it in the mode of arrangement and number of photophores. But as suggested by GILBERT (1913, p. 99), fragments of some luminous scales may have been mistaken for photopheres by TANAKA.

Lampanyctus townsendi (EIGENMANN & EIGENMANN)

Japanese name: *Gokô-hadaka*

Myctophum townsendi EIGENMANN & EIGENMANN, 1889, p. 125 (Cortez Banks near San Diego, California).

Lampanyctus townsendi JORDAN & EVERMANN, 1896, p. 558.—GILBERT, 1908, p. 230, pl. 4 (near Ua Huka Island, Marquesas Island, Pacific Ocean).—GILBERT, 1913, p. 98 (off southern Japan).—NORMAN, 1930, p. 238 (Cortez Banks, California).

Myctophum (*Lampanyctus*) *townsendi* BRAUER, 1906, p. 167.

A single female specimen obtained, Imp. Fish. Inst. Fish Sp. No. 4442, measuring 78.5 mm long (64.0 mm in body length).

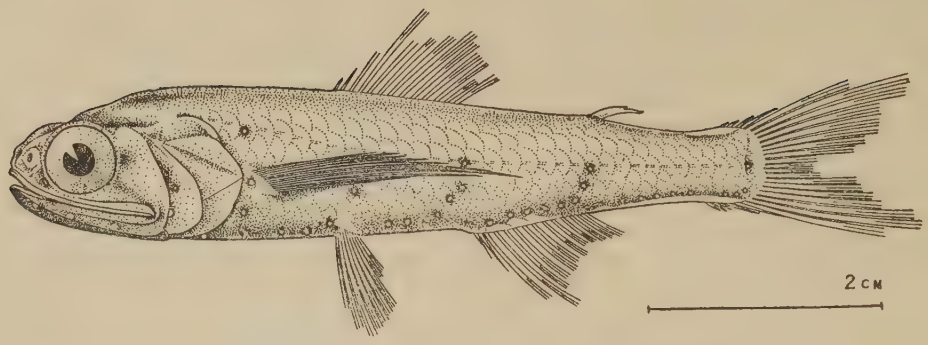

Fig. 11. *Lampanyctus townsendi* (EIGENMANN & EIGENMANN)

Agrees well with *Lampanyctus townsendi* of GILBERT taken in California, but differs from it in the points that the snout is shorter and blunter, somewhat shorter than half the diameter of eye (about $\frac{7}{10}$ in the latter); ventral inserted just below origin of dorsal (ventral inserted a little in advance of dorsal origin in the latter); about 10 luminous scales on underside of caudal peduncle, extending to end of base of anal fin (ending under first postero-anal photophore in the latter), and three larger ones along each side of base of anal fin (about 7 in the latter); pectorals very long, 1.10 times the length of head, extending posteriorly to base of seventh anal ray (pectorals mutilated in the latter).

Lampanyctus jordani GILBERT

Japanese neme: *Mame-hadaka*

Lampanyctus jordani GILBERT, 1913, p. 104, pl. 14 (Nemuro, Hokkaidô).

Two specimens were obtained, one larger is a female, 116.5 mm in body length measured to base of middle ray of caudal, the other smaller is

Fig. 12. *Lampanyctus jordani* GILBERT

a male, 105 mm, Imp. Fish. Inst. Fish Sp. Nos. 1899 and 1871. These specimens generally agree with the description and figure of the type. The depth of body in body length measured to base of middle ray of caudal, however, much lower than that of the type, 5.30 in larger one and 5.50 in the other instead of 4.35 as in the type. In the larger one the dorsal rays 14, anal rays 19 (13 and 18 in the type), the photophores 9 on antero-anal and 2 on cheek (8 and 1 in the type).

The accompanying figure is drawn from the larger specimen.

Diaphus gigas GILBERT

Japanese name: *Suitô-hadaka*

Diaphus gigas GILBERT, 1913, p. 93, pl. 12, fig. 2 (Sagami Bay)

Two male specimens obtained, Imp. Fish. Inst. Fish Sp. Nos. 1874 and 2055, measuring 39 and 49 mm respectively in body length.

In these specimens the third ventral photphore much higher than that of GILBERT's *Diaphus gigas* or even higher than BRAUER's *Myctophum* (*Diaphus*) *elucens* and nearly on the same level as middle photophore of supra-anals. Infra-orbital photophore well developed, meeting basally with the anterior part of premaxillary, but slightly produced dorsally beyond the small supra-preorbital photophore.

Dasyscopelus orientalis GILBERT

Japanese name: *Usu-hadaka*

Dasyscopelus orientalis GILBERT, 1913, p. 70, pl. 11, fig. 1 (Misaki).

A specimen measuring 55 mm long exclusive of caudal, Imp. Fish. Inst. Fish Sp. No. 2237, has come under my examination.

Agrees fairly well with GILBERT's *Dasyscopelus orientalis*, but differs from it in having 11 dorsal rays (13 in the latter) and 33 scales in lateral line (36 in the latter).

Fam. **Paralepidae**

Lestidium nudum GILBERT

New Japanese name: *Name-hadaka*

Lestidium nudum GILBERT, 1905, p. 607, fig. 236 (Pailolo Channel, between Molokai and Maui, Hawaii)— SCHMIDT, 1931, p. 22 (fish market of Kagosima).

The numbers of rays of pectoral, ventral and anal of my specimens

are fewer than those represented in figure and description of GILBERT's *Lestidium nudum*. The lengths of head, eye, snout and maxillary are somewhat shorter, the distance from tip of snout to origin of ventral and that of tip of snout to insertion of anal are slightly longer, the depth of body slightly deeper and the depth of caudal peduncle much higher than in the latter.

Six specimens obtained, their dimensions run as follows:

Sp. No.	4397	4396	4392	4393	4394	4395
Sex	♂	♀	♂	♂	♀	♂
BL(mm)	268.0	267.0	267.0	263.0	260.0	258.0
DO	9	9	9	9	?	?
A	32	31	31	31	33	32
P	12	11	11	11	12	12
V	9	9	9	9	9	9
H in BL	4.86	4.77	4.77	4.61	4.70	4.69
D in BL	10.51	10.47	11.22	9.85	10.48	11.37
SV in BL	1.75	1.76	1.73	1.70	1.76	1.72
SD in BL	1.60	1.61	1.57	1.58	1.60	1.56
SA in BL	1.28	1.28	1.27	1.26	1.27	1.26
VD in BL	23.72	21.89	18.67	23.91	18.57	21.15
VA in BL	4.81	4.70	4.78	4.89	4.66	4.76
DA in BL	6.31	5.87	6.39	6.12	6.30	6.19
E in BL	29.78	26.70	26.70	26.30	26.00	28.67
S in BL	9.47	9.64	9.71	9.46	9.63	9.49
M in BL	10.63	10.68	10.27	10.44	10.40	10.32
I in BL	39.41	37.61	39.26	37.57	36.11	38.50
DC in BL	38.29	34.23	39.26	35.07	37.14	36.86
BD in BL	29.78	31.41	28.40	29.89	31.71	29.66
BA in BL	5.31	5.39	5.59	5.42	5.39	5.49

Table 3. Measurements of *Lestidium nudum* GILBERT. (BL, body length measured to base of caudal; DO, dorsal rays; A, anal rays; P, pectoral rays; V, ventral rays; H, head; D, depth; SV, distance from tip of snout to origin of ventral; SD, from tip of snout to origin of dorsal; SA, from tip of snout to origin of anal; VD, from origin of ventral to that of dorsal; VA, from origin of ventral to that of anal; E, horizontal diameter of orbit; S, snout; M, upper jaw; I, interorbital space; DC, depth of caudal peduncle; BD, base of dorsal; BA, base of anal).

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VIII. On the Individual Variations Found in an Apodal Fish *Synaphobranchus pinnatus* (GRONOW), with Special Reference to its Taxonomy

Synaphobranchus was erected by JOHNSON in 1862 and seven species and two varieties, viz., *S. pinnatus* (GRONOW) (Syn. *Muraena pinnata* Gronow 1854 and *S. kaupii* JOHNSON 1862), *S. brevidorsalis* GÜNTHER 1887, *S. brachysomus* GILBERT 1905, *S. pinnatus* var. *brevidorsalis* LLOYD 1909, *S. pinnatus* var. *parvipinnis* ROULE 1916, *S. affinis* GÜNTHER 1877, *S. iraconis* JORDAN & SNYDER 1901, *S. jenkinsi* JORDAN & SNYDER 1901 and *S. takedae* TANAKA 1916, have been distinguished throughout the world, mainly by the difference in the origin of dorsal fin. Of these the last four are known from Japan.

In March 1937, the author procured 39 specimens from Akkesi in Hokkaidô and 5 from Tyôsi at depths of about 230 and 165 fathoms respectively, belonging to *Synaphobranchus*, varying from 472 to 806 mm in entire length and he has come to the conclusion that they are all referable to *Synaphobranchus pinnatus* (GRONOW), as already mentioned by TANAKA since they not only include all the forms corresponding to the above-mentioned species but also intermediate forms of varying degrees between any two of them.

It is my pleasant duty to express my gratitude to Prof. A. TERAO for his kindness in supervising the present work.

Description and Discussion

In the taxonomy of the present genus, the difference in the origin of dorsal fin is considered, by various authors, as the most important of all characteristics. But as shown in Fig. I the degree and extent of difference in the position of the origin of dorsal fin vary greatly in the specimens collected by the writer. All the hitherto known species

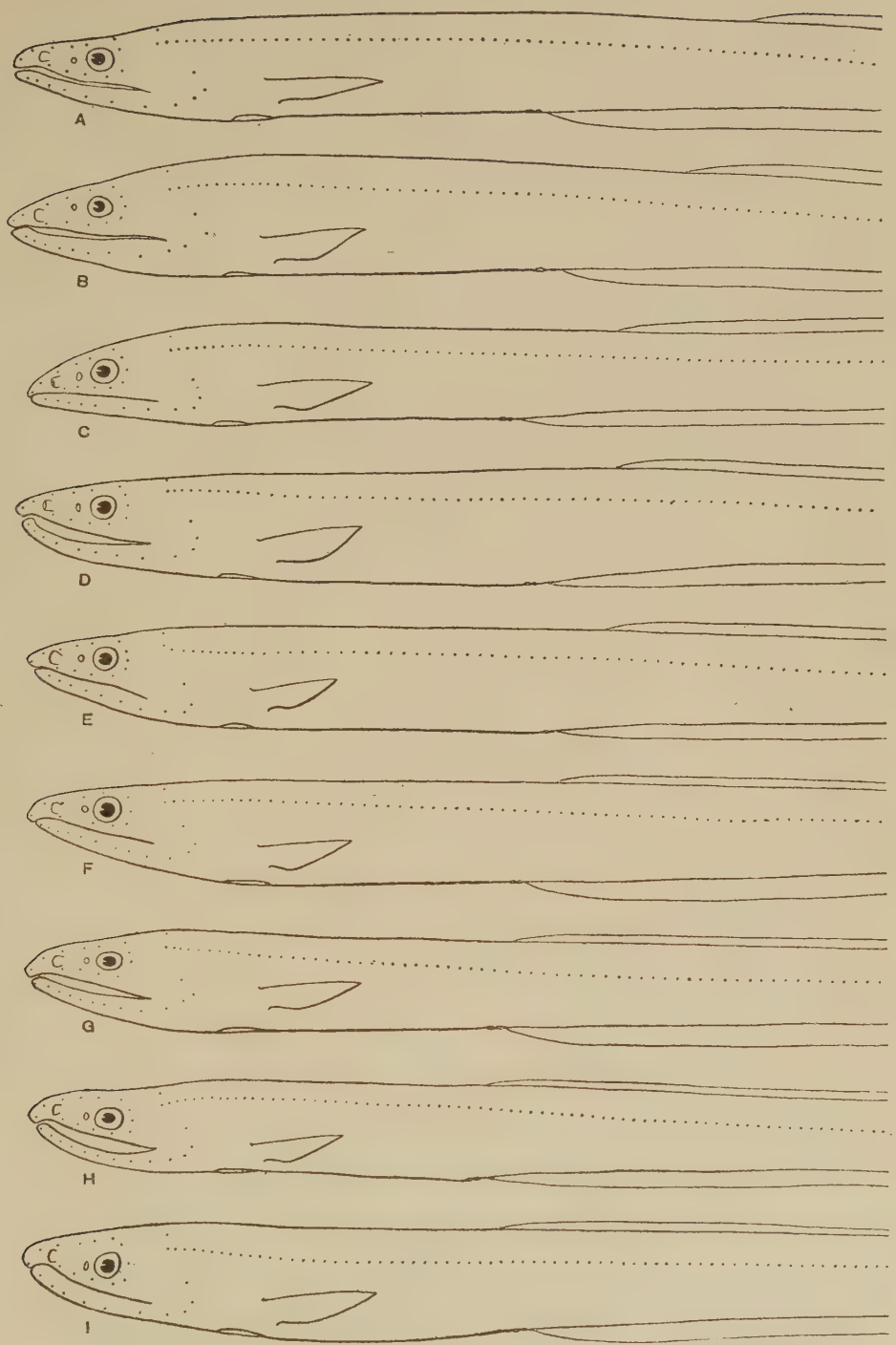

Fig. 13. Showing the variations of origin of dorsal fin of *Synaphobranchus pinnatus* (Gronow). A, ♀, 642 mm in total length; B, ♀, 692 mm; C, ♀, 618 mm; D, ♀, 668 mm; E, ♀, 636 mm; F. ♂, 628 mm; G, ♂, 586 mm; H, ♂, 583 mm; I, ♀, 614 mm.

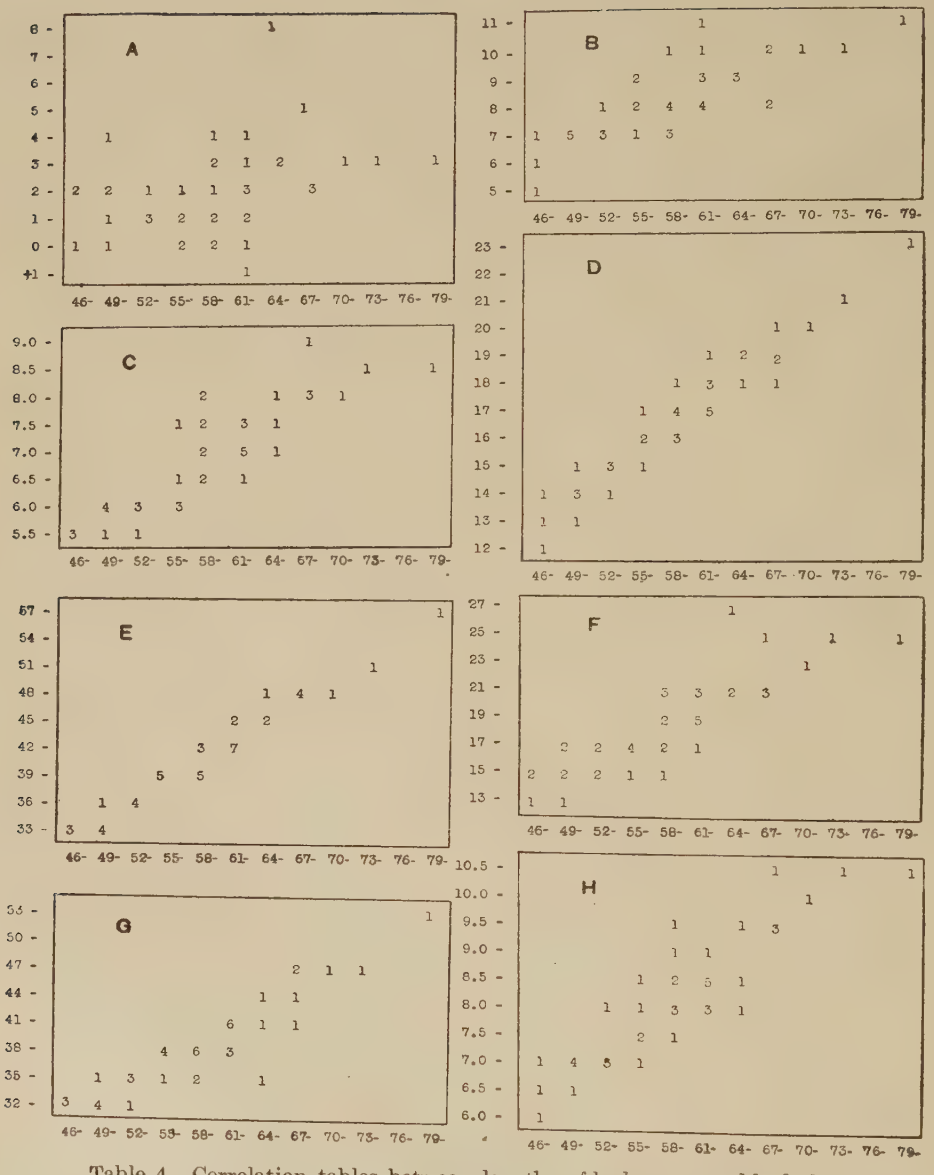

Table 4. Correlation tables between lengths of body parts and body length (in cm). A, distance from vent to origin of dorsal, + indicates the distance from vent when origin of dorsal is anterior to vent; B, length of trunk; C, length of head; D, length of head and trunk; E, length of tail; F, distance from tip of snout to origin of dorsal; G, distance from origin of dorsal to tip of caudal; H, distance from tip of snout to base of pectoral.

belonging to the genus *Synaphobranchus* are represented in this figure as follows: A: *S. pinnatus* (Gronow), *S. brevidorsalis* Günther, *S. jenkinsi* Jordan & Snyder, *S. pinnatus* var. *brevidorsalis* Lloyd and *S. pinnatus* var. *parvipnnis* Roule; B: *S. iraconis* Jordan & Snyder; G: *S. brachysomus* Gilbert; H: *S. affinis* Günther; I: *S. takedae* Tanaka.

The writer has extended his study to examine whether these differences are simply no more than individual variations or each of them serves as a standard for classifying the species by setting up correlation tables between length of body and the distance from vent to origin of dorsal, but he has found that it is absolutely impossible to divide the genus into several species as noted above (Table 4 A)

Again, the remarkably short trunk and the white margin of the fin have been regarded as important characteristics of *S. brachysomus*

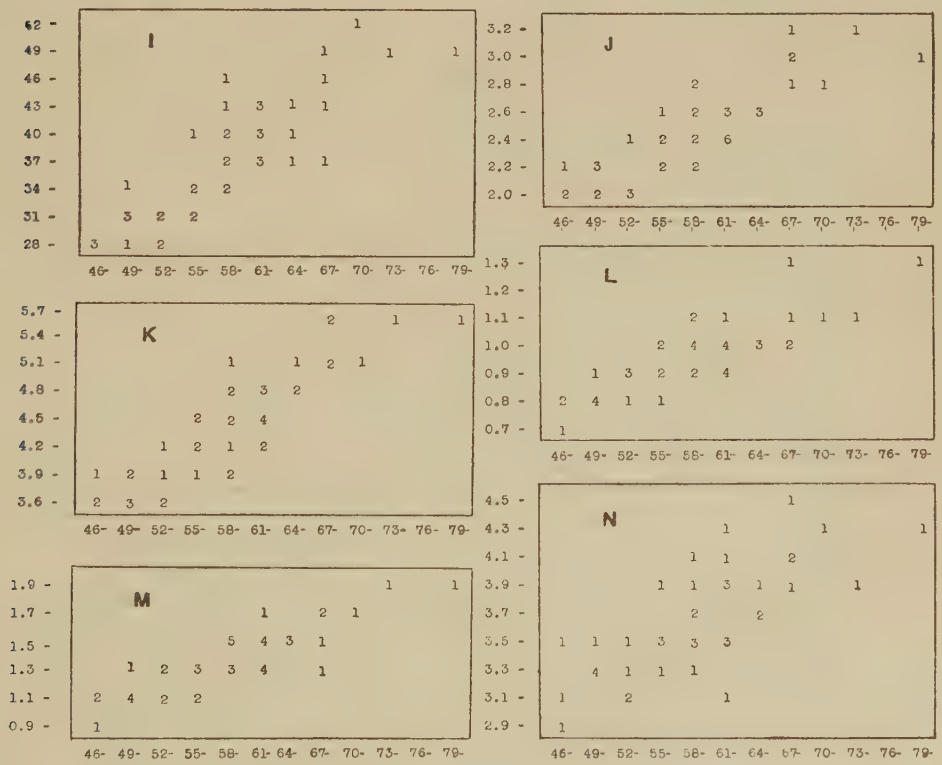

Table 5. Same as in Table 1. I, depth of body; J, length of snout; K, length of cleft of mouth; L, diameter of eye; M, interorbital space; N, length of pectoral.

Gilbert, but the trunk length is markedly variable as indicated in Table 4 B and the margins of the fins are more or less pale so far as my observations go.

Further, the correlations of the lengths of several parts of the body with the entire length of the body of the fishes, as given in Tables 4 C~H, and 5 clearly show that the species of the present genus represent a single group in these characters, viz., one species, *Synaphobranchus pinnatus* (Gronow).

To sum up, if the difference in origin of dorsal fin is to be treated as a point of difference in the taxonomic study of apodal fishes, the degree of variation of the origin of dorsal fin should be ascertained by comparing a large number of specimens. And in taxonomic study of apodal fishes, whose external characteristics are weakly developed, other various characteristics, which have not been used heretofore, should be taken into consideration.

Synonmy and References

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On the Japanese Atyid Shrimps*

Ituo Kubo

(Received Nov. 24, 1937)

I. Introductory

The Japanese atyid shrimps have been studied by many investigators, namely, de Haan (1849), Stimpson (1860), Ortmann, (1890～91), Doflein (1902), Rathbun (1902), Bouvier (1906), de Man (1908), Balss (1914), Kemp (1918), Uéno (1935), and others. But inasmuch as they are variable in several characters, their taxonomy is of no easy task.

I had of late opportunity to examine a considerable number of specimens of atyid shrimps collected from Japan and adjacent regions. Of the systematic categories hitherto proposed, four species, viz., *Caridina acuminata, C. brevirostris, C. harmandi* and *C. multidentata,* are not represented in the material at my disposal. The scrutiny of the material with special reference to the features of pleopods, however, enabled me to make emendations and additions in regard to atyid taxonomy. In the present paper are given erection of a new genus *Neocaridina,* to which *Caridina denticulata* of de Haan and a new subspecies, *Caridina denticulata koreana,* are referred, emendation of the characters of three genera *Caridina, Atya* and *Paratya,* creation of another new subspecies *Caridina japonica sikokuensis,* and addition of *C. serratirostris* to the Japanese fauna. A general consideration of the family in question is also dealt with in this paper on the basis of the features of the pleopods and some others.

Before proceeding any farther, I take this opportunity of expressing my warmest gratitude to Professor Arata Terao for his kind supervision under which the present work was carried out. My best thanks are due to Dr. Yaitirô Okada and Dr. Densaburô Miyadi for kindly placing the material from Formosa and Liu-Kiu at my disposal.

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I am also indebted to Mr. Sigeru KIMURA for the favour of the specimens from Shanghai, to Mr. Hirosi YOSIDA for a loan of Korean ones, and to Dr. Masuzô UÉNO, Mr. Densaburô INABA, Mr. Tune SAKAI, Mr. Masao KATAYAMA, Mr. Heiji IKEDA, Mr. Kazuiti MORI, Mr. Kiyomatsu MATSUBARA, Mr. Genkiti ABE, Mr. Kazuo KOBA, Mr. Yuichi ITO, Mr. Isao MATUI and other gentlemen for the collection of the material from various parts of Japan.

II. Descriptive

Family *Atyidae* KINGSLY

Key to the Japanese genera of Atyidae

a With exopodite on all legs; supraorbital spine present ..... ***Paratya.***

a_1. Without exopodite on all legs; supraorbital spine absent.

b. Pairs of chelipeds not similar, carpus of first pair short, its distal margin more or less concave.

c. Endopodite of first abdominal appendage enlarged, pear-shaped, without lobe-like protuberance at antero-outer angle of endopodite of first maxilliped ..... ***Neocaridina,*** n. g.

c_1. Endopodite of first abdominal appendage normal, endopodite of first maxilliped carries a lobe-like process at antero-outer angle ... ***Caridina.***

b_1. Pairs of chelipeds quite similar, carpus greatly concave on distal border ..... ***Atya.***

Genus *Paratya* MIERS

Paratya MIERS, 1882, p. 195; KEMP, 1917, p. 293; ROUX, 1926, p. 238.
Xiphocaridina, BALSS, 1914, p. 23; KEMP, 1912, p. 113.

Key to the species of *Paratya*

a. Upper border of rostrum with 16~25 spines, of wich the posterior 2~3 situated on median ridge of carapace ..... ***P. compressa.***

a_1. Upper border of rostrum serrated with 6~20 spines, the serration commencing from corneal region of rostrum (no spine on median ridge of carapace) ..... ***P. improvisa.***

Paratya compressa (de HAAN)

Ephyra compressa de HAAN, 1849, p. 186, Pl. 46.
Xiphocaris compressa, DOFLEN, 1902, p. 631; RATHBUN, 1902, p. 49; BOUVIER, 1905, p. 62.
Xiphocaridina compressa, KEMP, 1912, p. 114; BALSS, 1914, p. 23.
Paratya compressa KEMP, 1917, pp. 296~299, fig. 1, a~f; 1918, p. 293.

Table 1

	Species	Lot	Range	Mean	S.D.	C.V.
Upper rost. spine	*P. compressa*	C	16~25	20.7±0.04	1.02±0.02	4.93±0.26
		B	7~19	12.1±0.07	2.29±0.05	18.38±0.92
	P. improvisa	A	6~20	12.2±0.08	2.44±0.05	20.07±0.95
Lower rost. spine	*P. compressa*	C	1~5	2.4±0.06	0.78±0.04	31.99±1.87
		B	0~4	2.3±0.00	0.69±0.00	28.92±0.12
	P. improvisa	A	1~4	2.3±0.02	0.76±0.01	33.25±1.58

A. Female, 100 specimens obtained from Kasumi-ga-ura. *B.* Male, 100, locality same as in *A*. *C.* Female and male, specimens 70 in number, secured from various other places of Japan.

Carapace with supraorbital and antennal spines. Pterygostomian angle not spiniform. Rostrum almost horizontal but slightly convex at base (Fig. 2, *A*), with 16~25 spines (mostly 20~22) on upper and 1~5 spines (mostly 2~3) on lower border near the middle (Table 1 and Fig. 1), well beyond the antennular peduncle; it is feebler in male than in female. Telson subquadrate, armed on each posterior half of dorso-lateral border with 2 pairs of spinules, with about ten or more bristles on terminal margin (Fig. 2, *B*). Mandible without palp, somewhat Y-shaped, both the molar and incisor processes equally short (Fig. 3, *A* and *A'*). Palp of maxilla rudimentary (Fig. 3, *C*). Endopodite of first maxilliped densely fringed with distally

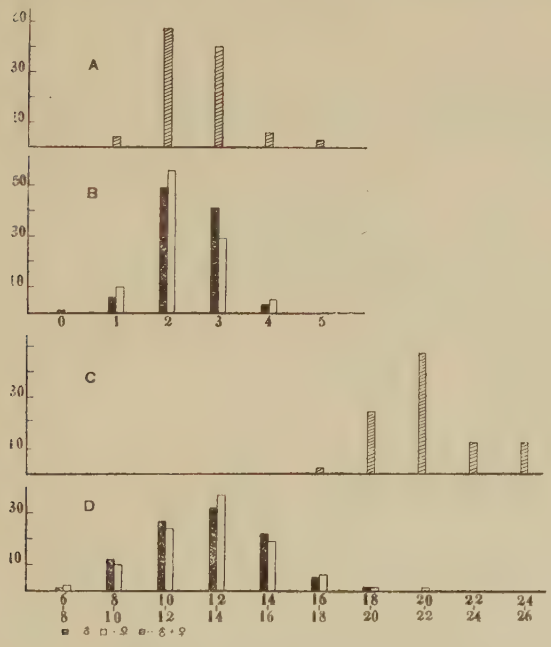

Fig. 1. Frequency histogram of rostral spine number. *A.* upper one, *B.* lower one of *P. compressa*; *C.* upper one, *D.* lower one of *P. improvisa*.

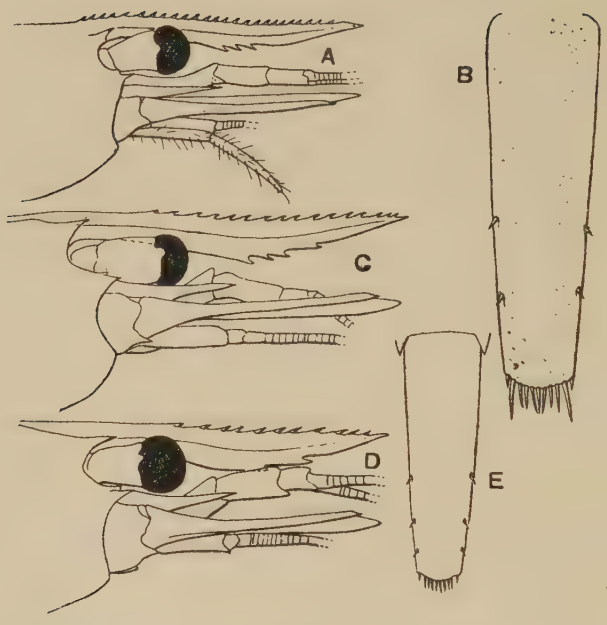

Fig. 2. *A*, Frontal aspect, of *P. compressa*, obtained from Kasumi-ga-ura, ♂, ×7.5; *B*, telson of the same specimen, ×15; *C* and *D*, *P. improvisa*, obtained from the same locality, ×7.5; *E*, telson of the same as in *E* ×7.5.

Fig. 3. Mouth parts of *P. compressa* except third maxilliped. *A*, mandible, outer view, ×ca. 23; *A'*. same, inner view; *B*, first maxilla, ×ca. 16; *C*, second maxilla, ×ca. 13; *D*, first maxilliped, ×ca. 13; *E*, second maxilliped, ×ca. 16.

jointed hairs on inner margin of its inner lobe, provided with a lobe-like protuberance at antero-outer angle (Fig. 3, *D*).

Endopodite of first abdominal appendage greatly differs in both sexes: in male, leaf-shaped, with its distal and inner corner elongated in the form of a stripe bearing a tuft of minute curled hairs near its apex, in female, simple, almost linear, acuminate at tip.

	h	*i*	*k*	*l*	*m*	*n*	*o*
Pleurobranchiae	—	—	1	1	1	1	1
Arthrobranchiae	—	1?	—	—	—	—	—
Podobranchiae	—	—	—	—	—	—	—
Mastigobranchiae	1	1	1	1	1	1	—
Exopodites	1	1	1	1	1	1	1

Localities: Itiki (Yuda), Kagosima Pref.; Hukuoka; Iwakuni River, Yamaguti Pref.; Kawasima, Tokusima Pref.; Kobata-numa, Kyôto Pref.; Gokasyo, Mie Pref.; Hukamizo, Miya, Katahara, Aiti Pref.; Toyama; Simoda, Yosida, Siduoka Pref.; Kasumi-ga-ura, Ibaraki Pref.; Murakami, Niigata Pref.; Nobezi, Aomori Pref.

Distribution: Main Island of Japan, Korea (Rathbun).

Note: The specimens at my disposal agree well with the description of de Haan of the present species, although his figure is not so confirmative. Kemp's account stands in complete harmony with my material with respect to several morphological characters, but his limitation of the distribution of this species as north as Lake Biwa should be lifted since I have obtained specimens even from the northern end of the Main Island of Japan as already given in the list of localities.

Paratya compressa improvisa Kemp

Paratya compressa improvisa Kemp, 1917, p. 299, fig. 2 (a~f) and fig. 3; 1918, p. 293.

Carapace provided with supraorbital and antennal spines, pterygostomian angle rounded. Rostrum almost horizontally straight, with 7~19 spines on upper from corneal region distad in male but 6~20 ones in female, with 0~4 spines on lower distal half in male but 1~4 in female (Fig. 1, *B* and *D*), reaching beyoned antennular peduncle by about one-fourth of its length (Fig. 2, *C* and *D*). Telson subquadrate, armed with two or three pairs of spinules on distal half of dorso-lateral border fringed with ten spinules on terminal border

(Fig. 2, *E*). Mouth-parts entirely same as in the previous species in general aspects. Endopodite of first abdominal appendage leaf-shaped, usually with serrations and comparatively short bristles on inner margin but long ones on outer margin, provided with a bar-shaped elongation at distal inner angle, giving off minute curled hairs at tip. (Fig. 4).

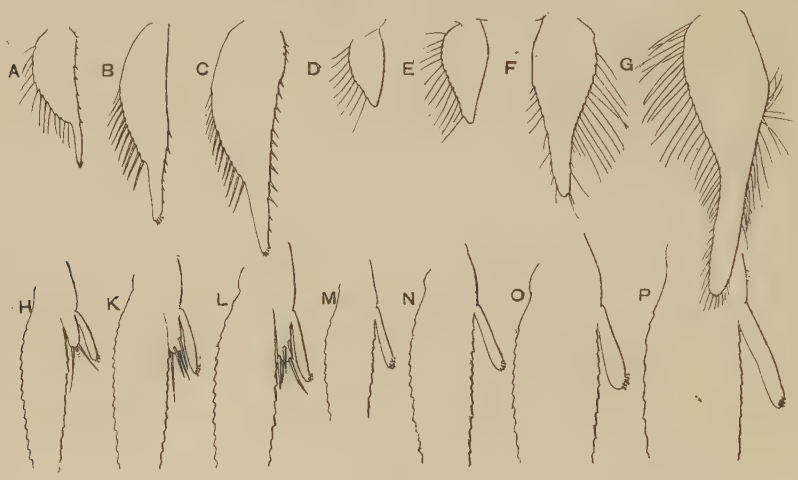

Fig. 4. Upper series: endopodite of first abdominal appendage, lower series: that of second abdominal appendage; each figure with ×24; numerals representing body length in mm. *A*, 13.0, ♂; *B*, 15.0, ♂; *C*, 18.5, ♂; *D*, 14.0, ♀; *E*, 17.0, ♀; *F*, 21.0, ♀; *G*, 24.0, ♀; *H*, 13.0, ♂; *K*, 15.0, ♂; *L*, 18.5, ♂; *M*, 14.0, ♀; *N*, 17.0, ♀; *O*, 21.0, *P*, 24.0, ♀.

Endopodite of second abdominal appendage carries stylamblys and appendix masculina which is provided with a tuft of setae at apex in male (Fig. 4, *H*~*L*), but with stylamblys only in female as shown in Fig. 4, *M*~*P*.

Localities: Yosida, Siduoka Pref.; Lake Suwa, Nagano Pref.; Lake Kawaguti, Yamanasi Pref.; Yamaguti, Saitama Pref; Urayasu, Tega-numa, Tiba Pref.; Kasumi-ga-ura, Ibaraki Pref.; Aidu, Hukusima Pref.; Murakami, Niigata Pref.; Kinomata and Ôisida, Yamagata Pref.; Aisaka, Aomori Pref.

Note: The correlation coefficients between body length (1), rostral length (2), upper rostral spine number (3), and lower rostral one (4) were computed, and as shown in the following table no correlation was found to exist between rostral length and rostral spines, although a

significant correlation was observed to occur between body length and rostral length.

Sex	No. of specimens	$r_{1\cdot2}$	$r_{2\cdot3}$	$r_{2\cdot4}$	$r_{3\cdot4}$
♂	100	0.54±0.04	0.05±0.06	0.32±0.06	0.29±0.06
♀	100	0.73±0.03	0.19±0.06	0.04±0.06	0.31±0.06

Sexual dimorphism is evident in the present species in body length, and features of endopodites of first and second abdominal appendages. Males are much smaller than female as shown in the following table :—

Sex	No. of specimens	Range (mm)	Mean	S.D.	C.V.
♂	100	16.0～21.0	18.73±0.08	1.29±0.08	13.77±0.66
♀	100	19.0～28.5	23.57±0.06	1.02±0.04	8.66±0.41

The reader is referred to the accompanying figueres (Fig. 4, *A*～*P*) for the differences in both sexes in regard to the endopodites of first and second abdominal appendages. The differentiation is observable even in such small specimens as 10 mm long (without rostrum).

Remarkable as they are, the appendages in question do not serve to dintinguish *P. compressa improvisa* from the typical form of *P. compressa*. The differences between the two are, as already pointed out by Kemp, to be seen in the number of upper rostral spines and situation of the hindmost upper rostral spine.

Genus ***Neocaridina*** gen. nov.

Body smooth. Carapace with rostrum and antennal spine, without supraorbital one, antero-lateral border spiniform. Mandible carries no palp. Endopodite of first maxilliped provided with no process on the distal outer border. Two pairs of chelipeds not similar, the second much longer than the first. Frontal border of carpus of the first thoracic legs more or less excavated. Endopodite of first abdominal appendage pear-shaped and greatly enlarged in male, subtriangularly elongated in female. Appendix masculina of second abdominal appendage much enlarged and covered with thickly set

Fig. 5. Endopodite of first maxilliped. A, *N. denticulata* (collected from Unzen, Nagasaki Prefecture), ×35; B, *N. dent. sinensis* (Shanghai, China), ×35; C, *N. dent. koreana* (Huzan, Korea), ×35; D, *N. denticulata* (Yaidu, Siduoka Prof.), ×35; E, *N. denticulata* (Hukuyama, Hirosima Pref.), ×20; F, *C. japonica sikokuensis*, ×35. G. *C. japonica*, ×20; H, *C. serratirostris*, ×50; K, *C. leucosticta*, ×35; L, *C. grandirostris*, ×50; M, *C. typus*, ×35.

stout setae in male.

The present genus is closely allied to the genus *Caridina* but differs from it by the following important characters:— (1) Endopodite of first maxilliped without protuberance on its distal outer margin (Fig. 5); (2) endopodite of first pleopod greatly enlarged and pear-shaped in male, subtriangularly elongated in female; (3) appendix masculina of second abdominal appendage much enlarged, thickened and densely covered with setae.

Type species: *Neocaridina denticulata* (de HAAN)=*Caridina denticulata* de HAAN.

Key to the species of *Neocaridina*.

a. Endopodite of first abdominal appendage greatly dilated in the distal half, the proportion between length and width (in the widest region) about 1: 1.2 in full grown specimen.
  b. Rostrum much beyond the antennular peduncle .....**N. denticulata.**
  b_1. Rostrum not beyond the antennular peduncle .....**N. denticulata sinensis.**
a_1. Endopodite of first pleopod pear-shaped, not so much dilated in its distal half, with the proportions: length 1.7, breadth (in the widest region) 1.
  .....**N. denticulata koreana,** subsp. nov.

Neocaridina denticulata de HAAN

Caridina denticulata de HAAN, 1849, p. 186, Taf. 45. fig. 8; DOFLEIN, 1902, p. 632, Text. fig. D; RATHBUN, 1902, p. 49; BALSS, 1914, p. 24; KEMP, 1918, p. 286, Text fig. 11.

Carapace with almost horizontally straight rostrum, antennal spine, but without supraorbitale one, anterolateral margin spiniform. Rostrum feebler in male than in female (Fig. 6, *A* & *B*), reaching to or well beyond

the tip of antennular peduncle (Fig. 7, *A*～*F*), armed with 10～20 spines on upper, (Table, 2.) the posterior 3 or 4 spines of which situated on carapace, without spines on distal two-fifths, with 0～7 spines on

Table, 2.

	Locality	No.	Range	Mode	Mean	S. D.	C. V.
No. of upper rostral spine	Shanghai	41	8～19	16～18	15.8±0.11	2.16±0.08	13.6±1.03
	Huzan (Korea)	131	12～20	16～18	15.6±0.06	2.07±0.04	13.2±0.56
	Hukuyama	83	10～20	16～18	15.4±0.07	1.99±0.05	12.9±0.68
No. of lower rostral spine	Shanghai	41	1～9	4～6	4.7±0.07	1.50±0.05	31.9±2.61
	Huzan (Korea)	131	2～10	4～6	5.6±0.04	1.48±0.03	26.4±1.17
	Hukuyama	83	0～7	4～6	4.7±0.04	1.29±0.03	27.1±1.52
Length of rostrum (mm)	Shanghai	41	2.5～4.6	3.0～3.5	3.4±0.09	0.46±0.06	13.7±1.04
	Huzan	131	2.5～5.0	3.5～4.0	3.7±0.05	0.49±0.04	12.9±0.54
	Hukuyama	83	3.9～6.0	4.5～5.0	4.7±0.07	0.48±0.05	10.2±0.54

Shanghai..... *Neocaridina denticulata sinensis.* Huzan..... *N. dent. koreana.* Hukuyama (Hirosima Prefecture)..... *N. denticulata.*

rather anterior half of the lower (Table, 2.). Telson ornamented with three or four pairs of spinules on dorsal distal two-thirds, each pair at nearly the same intervals, convex on terminal margin which bears 12～14 spinules (Fig. 6, *F*～*G*). Mandible without palp. Endopodite of first maxilliped comparatively broad, inner margin of the lobe of the maxilliped densely set with proximally simple and distally jointed long setae, without lobe-like process at distal and outer corner (Fig. 8, *D*.) First cheliped short, with the proportions against the finger : meropodite 2.6, carpopodite ca. 1.8, palm ca. 0.9 ; anterior distal margin of carpopodite somewhat excavated. Second cheliped more slender and much longer than the first one, the proportions : meropodite about 3.3, carpopodite ca. 2.5, palm 0.96. Third leg longer than second one, proportions against dactylus : merus 4.2, carpus 3, propodus 3.8 ; merus ornamented on the posterior margin with one distal largest spine and three proximal smaller spines situated at equal intervals, carpus with a rather large spine near distal border on the outer side, propodus carries many spinules on posterior border ; dactylus provided with six spinules on posterior border (Fig. 6, *E*).

Endopodite of the first abdominal appendage in male inverted

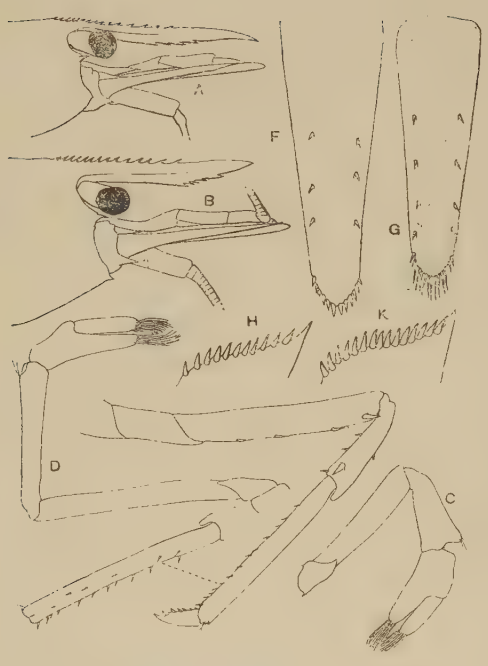

Fig. 6. *A*, Frontal aspect of *N. denticulata* secured from Kobata-ike, Kyoto Prefecture, ♂, ×5; *B*, same as in *A*, ♀, ×5; *C*, first cheliped of same specimen, ×10; *D*, second cheliped, ×10; *E*, third pereiopod, ×10; *F*, telson, ×10; *G*, telson (specimen obtained from Hukuyama, Hirosima Pref.), × Ca. 13; *H*, uropodal spine (Hukuyama), ♂ ca. 33; *K*, same as in *H*, ♀, ×ca. 33.

pear-shaped and greatly enlarged in its distal half, ratio of length to greatest breadth: 1.2 (Fig. 9, *A*~*C*), carrying a stylamblys on the inner border, distal peripheral region densely covered with spinules; the same in female elongated subtriangular in shape, fringed with hairs on outer margin, covered with a thicket of short spinules near the middle of inner margin (Fig. 9, *K*, *M*, and *O*). Appendix masculina of second pleopod much enlarged and thickened, much longer than stylamblys, covered with densely set setae in its distal half.

Localities: — Beppu, Ôita Pref.; Nagasaki, Unzen, Nagasaki Pref.; Hukuoka; Hukuyama, Hirosima Pref.; Kobata-ike, Kyôto Pref.; Yaidu, Siduoka Pref.

Distributions: Main Island of Japan (de HAAN); Peking (DOFLEIN); Hikone, Japan (KEMP).

Branchial formula:

	h	*i*	*k*	*l*	*m*	*n*	*o*
Pleurobranchiae	—	r	1	1	1	1	1
Arthrobranchiae	—	1	1	—	—	—	—
Podobranchiae	1	—	—	—	—	—	—
Mastigobranchiae	—	1	1	1	1	1	—
Exopodite	1	1	—	—	—	—	—

Note: Endopodite of the first pleopod greatly characterized in male as previously mentioned, but it is not so much enlarged in its

immature stage (about 10 mm in body length without rostrum), viz., the proportions of the length against the breadth: 2 (Fig. 9, *D*). Appendix masculina unusually enlarged in full grown male, but not in the specimens of about 10 mm and downwards in body length

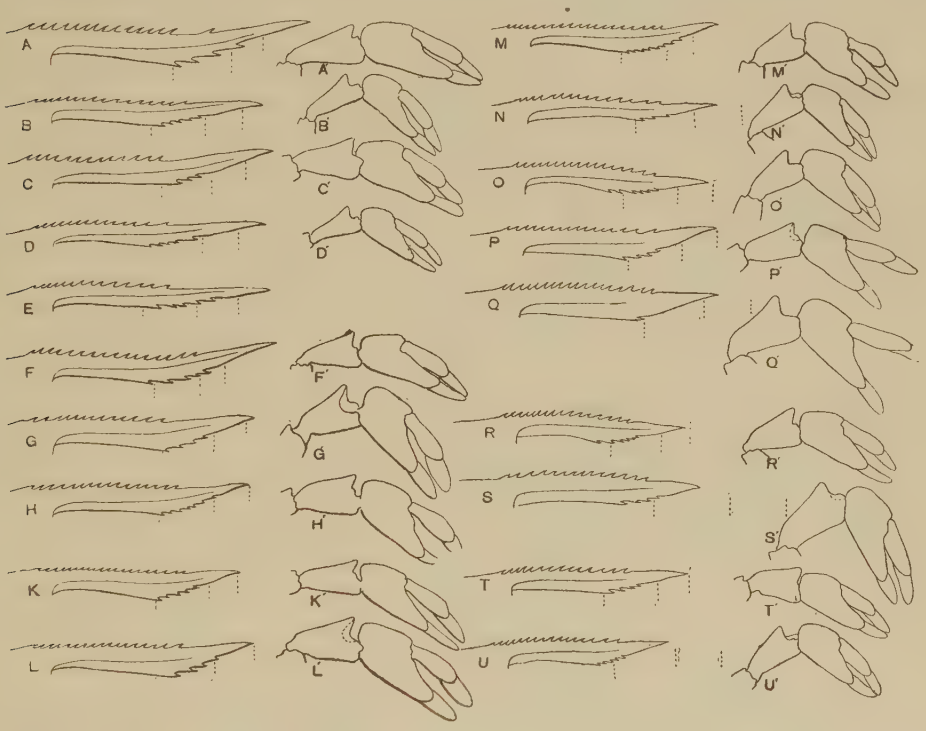

Fig. 7. Rostrum, magnified 7 times (dotted lines indicating terminal end of each segment of antennular peduncle) and distal three joints of first cheliped magnified 10 times respectively. *A*~*F* and *A'*~*F'*, *N. denticulata* secured from Hukuyama, 3 ♂, 3 ♀; *G*~*M* and *G'*~*M'*, *N. dent. koreana* from Huzan, 2 ♂, 3 ♀; *N*~*U*, *N. dent. sinensis* from Shanghai, 2 ♂, 8 ♀.

excluding rostrum, being somewhat larger than stylamblys (Fig. 9, *II*).

Although imperfectly illustrated in his figure, de Haan's description of *Caridina denticulata* tallies completely with the specimens at my disposal. It seems to me highly probable that the lack of the elongation of the distal outer angle of the endopodite of first maxilliped and the enlargement of the endopodites of first and second abdominal appendages were overlooked by de Haan. It follows therefore that de Haan's

C. denticulata should be included in the newly created genus.

Neocaridina denticulata sinensis (Kemp)

Caridina denticulata sinensis Kemp, 1918, p. 287, text-fig. 11 (c, d); Uéno, 1935, p. 270, fig. 1 (A~G).

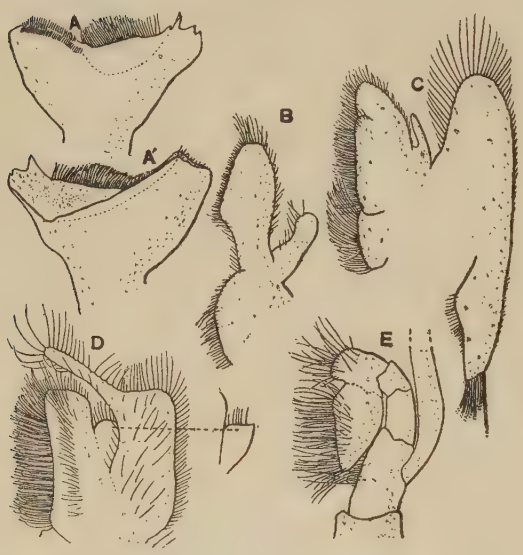

Fig. 8. Mouth parts of *N. denticulata*. *A*. mandible, outer view, × 28. *A'*. inner aspect of mandible, × 28. *B*. maxillula, × 20. *C*. maxilla, × 16. *D*. first maxilliped, × 16. *E*. second maxilliped, × 20.

Rostrum horizontal, not surpassing antennular peduncle, armed with a rather sparse series of 8~19 spines (mostly 16 ~18, 15.8 on the average) extending over one-third from tip proximad to the median ridge on the carapace (spines on the ridge 2~4), provided with 1~9 spines on lower border (mostly 4~6, 4.7 on the average) (Fig. 7, *N*~*U*). Carapace moderately compressed, antennal spine present, supraorbital one absent, pterygostomian angle pointed. Mouth-parts entirely the same as in *N. denticulata*. First cheliped short, palm 0.8 times, carpus about 1.4 times as long as movable finger, excavated on anterior border (Fig. 7, *N'*~*U'*). Second cheliped much longer than first one, proportions of its distal three segments against finger: palm 0.7, carpus 1.8. Third and fourth thoracic legs similarly slender; third one with proportions against dactylus: propodus 3, carpus 2, merus 4; dactylus usually with five spinules on inner margin, the propodus provided with about 15 spines on posterior border. Fifth leg a little shorter than the previous two, with dactylus bearing stout bristles on inner margin. Endopodite of first and second pleopods similar in both sexes, quite resembles that of *N. denticulata*.

Localities: — Uzantô, Rigyo-ti (Formosa), Isigaki-Zima (Liu-Kiu).

Shanhai.

Distribution: Peking (KEMP).

Note: The present subspecies is closely allied to the typical from of *N. denticulata* (de HAAN), but was separated from it by KEMP (29) by the following two characters: (1) Both upper and lower rostral spines

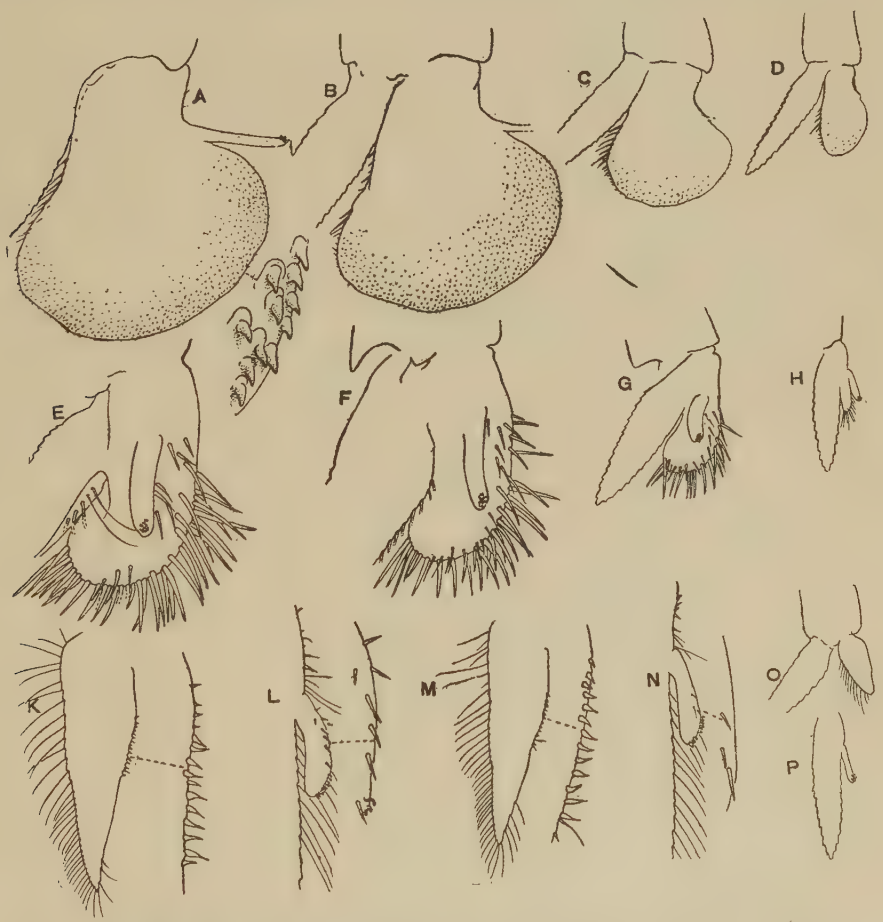

Fig. 9. *A*, Endopodite of *N. denticulata* of first pleopod in male, body length, 19 mm; *B*, same as in A, 16 mm; *C*, same as in *A*, 11 mm; *D*, same as in *A*, 10 mm; *E*, endopodite of second pleopod in male, 19 mm; *F*, same as in *E*, 16 mm; *G*, same as in *E*, 11 mm; *H*, same as in *E*, 10 mm; *K*, endopodite of first pleopod in female, 23 mm; *L*, inner border of second pleopod of female, 23 mm; *M*, same as in *K*, 20 mm; *N*, same as in *L*, 20 mm; *O*, first pleopod of female, 10 mm; *P*, endopodite of second pleopod, 10 mm; (each figure magnified 28 times).

rather numerous, varying from 14 to 22 on upper margin and 3 to 8

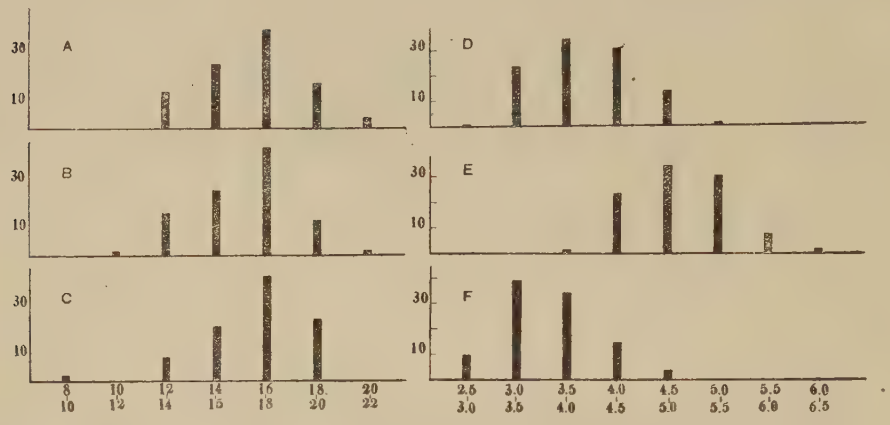

Fig. 10. Frequency histgram. *A*, upper rostral spine number of *N. dent. koreana* collected from Huzan; *B*, same as in *A*, *N. denticulata* from Hukuyama; *C*, same as in *A*, *N. dent. sinensis* from Shanghai; *D*, length of rostrum, *N. dent. koreana*; *E*, same as in *D*, *N. denticulata*; *F*, same as in *D*, *N*, *dent. sinensis*.

on lower one; (2) anterior border of carpus of first thoracic leg more deeply excavated than that of the typical form of *N. denticulata*.

But my observations on the specimens from Formosa and Shanghai do not warrant one to separate the two forms on the basis of the characters in question (Figs. 7, 10 and 11). It may be mentioned that the rostrum is much shorter in my specimens than that of the typical form and this character may be utilized to distinguish the present subspecies from the latter (Table 2, Figs. 7, 10 and 11). Of the caridid species studied by Bouvier, *Caridina davidi* (1905, p. 83) stands most closely to *N. denticulata sinensis* Kemp in morphological characters and in the locality as well. The absence of spiniform pterygostomian angle, however, separates Bouvier's form from Kemp's.

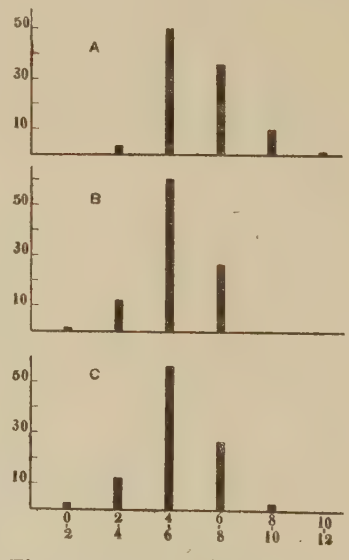

Fig. 11. Frequency histgram of lower rostral spine number. *A*, *N. dent. koreana*; *B*, *N. denticulata*; *C*, *N. dent. sinensis*.

Neocaridina denticulata koreana, subs p. nov.

Carapace about 1.5 times as long as rostrum, with no supra-orbital and antennal spines, pterygostomian margin spiniform. Rostrum almost horizontally straight, almost reaches to or slightly beyond the apex of antennal peduncle (Figs. 7 and 10), with 12～20 spines on upper border (mostly 4～6, 5.6 on the average) (Table 2, Figs. 10 and 11). Mandible without palp. Endopodite of first maxilliped without process at the distal outer angle (Fig. 5, *C*). First cheliped rather short, with proportions against finger : palm 0.9, carpus 1.2, merus 1.4 ; moderately excavated on anterior distal border. Second cheliped much longer than first, ratios to finger : palm 0.9, merus 2.0. Last three pairs of legs with regularly set longitudinal spinules on lower border, 3 on merus, 3 or 4 on carpus, about 15 on propodus. Branchial arrangement entirely the same as in *N. denticulata*. Endopodite of first pleopod pear-shaped, length about 1.7 times as long as breadth in male, it is lobular in female, elongated subtriangular in shape, provided with long hairs on outer margin, with a thicket of short setae near the middle region of the inner margin (Fig. 12, *E*～*K*). Endopodite of second abdominal appendage with stylamblys and much longer appendix masculina,

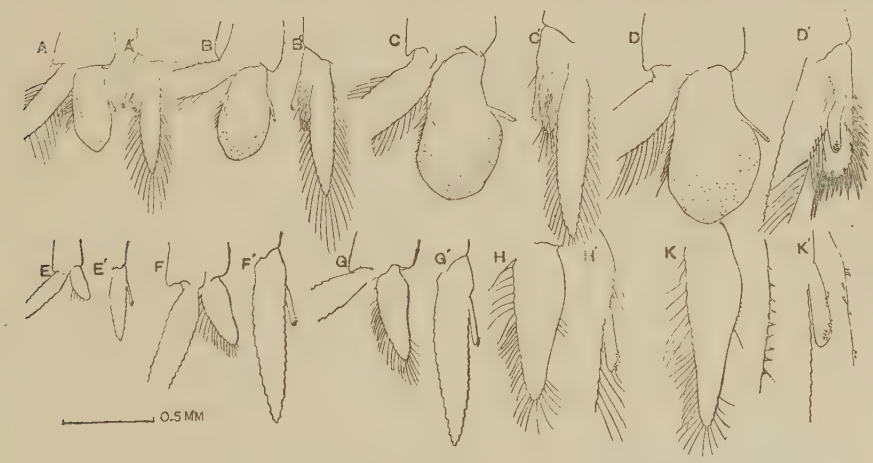

Fig. 12. Endopodite of first (simple letter) and second pleopod (dashed letter). of *N. dent. koreana;* upper series, male, lower series, female; magnification about 23. *A*, *A'*, body length 10.0 mm, *B*, *B'*, 12.4 mm. *C*, *C'*, 15.0 mm. *D*, *D'*, 19.0 mm ; *E*, *E'*, 5.5 mm ; *F*, *F'*, 13.0 mm ; *G*, *G'*, 15.0 mm ; *H*, *H'*, 20.5 mm ; *K*, *K'*, 23.0 mm.

which is fringed with comparatively long setae on inner and distal margins in male (Fig. 12, *A′*~*D′*), but with stylumblys only in female (Fig. 12, *E′*~*K′*).

The above mentioned description is based on 66 male specimens, ranging 10~20 mm in body length without rostrum and 65 female specimens, ranging 10~24 mm in body length. These specimens were secured from Huzan fish market by Mr. Hirosi Yosida.

Type locality: Huzan (Korea).

Note: Rostral length does not correlate with rostral spines on upper and lower borders, since the correlation coefficient with upper ones is 0.47 ± 0.04 and with lower ones 0.04 ± 0.05.

Endopodite of first pleopod in younger male about 10 mm in body length excluding rostrum lobe-shaped, the ratio of the length to the breadth about 2.4.

The present subspecies is closely allied to the typical form of *N. denticulata* (de Haan) and to another subspecies *N. denticulata sinensis* (Kemp), but it is easily distinguishable from them in having endopodite of first abdominal appendage as well as appendix masculina of second pleopod in grown up male smaller than those of the males of the latter two forms. These criteria do not hold true in the three forms when they are younger (Figs, 9 and 11).

Genus *Caridina* Milne-Edwards, emend.

Caridina Milne-Edwards, 1837. p. 362; Bate, 1888, p. 702; de Man, 1892, p. 363; Kemp, 1918, p. 274; Blanco, 1935, p. 31.

Carapace acuminated at rostrum and antennal spine. Pterygostomian angle rounded. Mandible without palp. Endopodite of first maxilliped provided with a lobe-like protuberance at outer angle. First shorter and second longer pairs of thoracic legs chelate, chela with a tuft of hairs at apex. First cheliped with carpus moderately excavated on distal border. Branchial formula runs as follows:—

	h	*i*	*k*	*l*	*m*	*n*	*o*
Pleurobranhiae	—	r	1	1	1	1	1
Arthrobranchiae	—	1	1	—	—	—	—
Podobranchiae	1	—	—	—	—	—	—
Mastigobranchiae	—	1	1	1	1	1	—

Exopodite absent on all thoracic legs.

Key to the species of the genus *Caridina*

a. Without spines on upper border of rostrum .....**C. *typus*.**
a_1. With spines on upper border of rostrum
  b. With several terminal spines on rostrum
    c. Rostrum remarkably long, surpasses antennular peduncle by half, dorsal spineless portion covering a distal half or so. Endopodite of first pleopod with stylumblys in male. .....**C. *grandirostris*.**
    c_1. Rostrum not so long, slightly beyond apex of the antennular peduncle, spineless along distal one-fourth of dorsal. Endopodite of the first pleoped without stylumblys .....**C. *leucosticta*.**
  b_1. Without terminal spines on rostrum
    d. Dorsal median ridge of carapace without spines behind the level of the orbital notch
      e. Rostrum rather long almost horizontal or slightly directed downwards, almost reaching to or well beyond the second segment of antennular peduncle. .....**C. *japonica*.**
      e_1. Rostrum short, directed obliquely down-wards, not surpassing the first joint of antennular peduncle....**C. *japonica sikokuensis*** subsp. nov.
    d_1. Dorsal median ridge of carapace with many spines behind the level of the orbital notch. .....**C. *serratirostris*.**

Caridina typus Milne-Edwards

Caridina typus Milne-Edwards, 1837, T. II, p. 363, pl. 25, figs. 4 and 5. Bate, 1888, p. 704, pl. 119, fig. 3; Bouvier, 1904, p. 134; 1905, p. 88, fig. 10; Roux, 1929, p. 235; 1904, p. 552; Edmondson, 1935, p. 14, fig. 3, g~l; de Man, 1892, p. 367, Taf. 21, fig. 22.
C. exilirostris Stimpson, 1860, p. 30.

Rostrum short, reaching to about the middle of penultimate segment of antennular peduncle, directed somewhat downwards, distal portion lanceolated, upper border without spine, but lower one with 0~4 spines. Supraorbital spine absent and antennal one present. Pterygostomian angle rounded (Fig. 13, *A*). Telson subrectangular, length about 3.4 times as long as the breadth of distal border, dorsally ornamented with 6 pairs of spinules in the distal two-thirds, distal margin convex and armed with 14 setae (Fig. 13, *F*). Outer margin of antennal scale ends in a spine which stretches to the level of the apex of the antennular peduncle. Mandible without palp. Endopodite of first maxilliped bears a process at outer angle (Fig. 5, *M*). First cheliped the shortest of all legs, proportions against finger: palm 1.1, carpus 1.5, merus 1.7; carpus more or less excavated on distal border.

Second cheliped slender and longer than the first one, ratios to finger: palm 0.73, carpopodite 2.2, meropodite 2.1, ischiopodite 1.1. Third pereiopod stouter and longer than the second, dactylus with 6 spines on its inner border; propodus armed with many spinules on posterior surface; carpus about 0.6 times as long as propodus, with a stout spine near distal posterior; merus about 1.5 times as long as propodus, with one terminal and other three spinules set at equal intervals on posterior border (Fig. 13, *D*). Fifth leg longer than fourth, dactylus with about 60 setae on the inner margin (Fig. 13, *E*.).

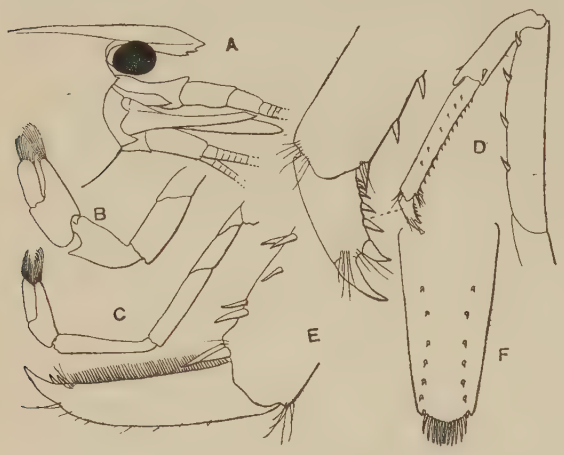

Fig. 13. *A*, Frontal aspect of *C. typus*, ♀, ×4; *B*. first cheliped, ×8; *C*, second cheliped, ×6; *D*, third leg, ×6; *E*, tip of fifth leg, ×40; *F*, telson, × ca. 8.

The above description is based on numerous adult and young specimens from 11 to 30 mm in body length.

Localities: Simoda, Yaidu, Siduoka Pref.; Yuda (Itiki), Kagosima Pref.; Okinawa, Miyakozima, Iriomote-zima (Liukiu Island)

Distributions: Flores, Saleyer, Celebes (de Man); Suva (Edmondson); Lombok (Roux).

Note: Endopodite of first abdominal appendage

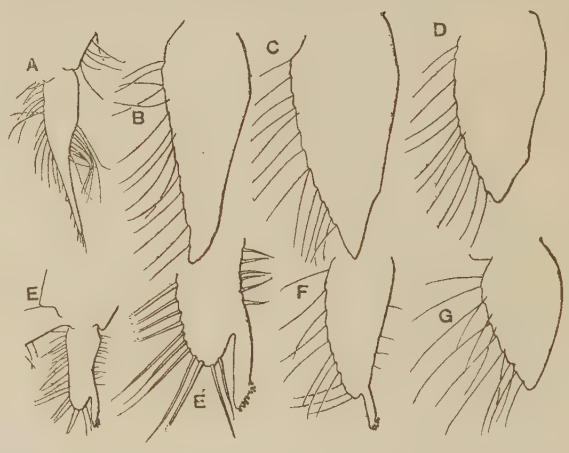

Fig. 14. Endopodite of first pleopod of *C. typus*, upper series: female, lower series: male. *A*, ovigerous, body length, 30.0mm, ×12; *B*, 17 mm, ×60; *C*, 14 mm, ×80; *D*, 13 mm, ×80; *E*, 22 mm, ×16; *E'*, same as in *E*, ×40; *F*, 13 mm, ×80; *G*, 11 mm, ×80.

at first makes its appearance as a small oval lobe in both sexes at a stage about 11 mm in body length without rostrum (Fig. 14, *G*). In male stylamblys buds out its inner terminal margin when the animal is about 12 mm long without rostrum (Fig. 14, *F*), whilst the opposite distal outer angle assumes an auricular shape when mature. Female lacks stylamblys in the appendage in question which is acuminate at tip.

Presence or absence of spines on rostrum appears to be one of the most important criteria to distinguish *C. typus* Milne-Edwards from *C. acuminata* Stimpson. As already remarked by de Man, such character, however, falls within the range of individual variations of my specimens. But Balss's (1914) specimens of *C. acuminata* obtained from Ito, Prov. Idu show discrepancy to the material at my disposal in having 7 spinules (instead of 60 setae) on the posterior border of fifth leg. His description and figure leave much to be desired from the viewpoint of taxonomy so that we are not in a position to decide between the alternatives whether or not *C. acuminata* of his is identical with *C. typus* Milne-Edwards.

Caridina grandirostris Stimpson

Caridina grandirostris Stimpson, 1860, p. 28.

Carapace with antennal spine, but without supraorbital one, pterygostomian angle rounded. Rostrum somewhat longer than carapace, mostly with 14 spines (ranging from 14 to 22) arranged from the middle of upper border proximad to the median ridge, on which 2 of the spines are situated, with 2 or 3 spines at apex, and with mostly 18 (ranging from 10 to 20) overlapping spines on inferior border (Fig. 15, *A*). Telson slender, with five short pairs of spinules on dorsolateral sides, with four pairs of longer spinules on obtusely pointed distal border (Fig. 15, *L*). Uropods with 11 spines as shown in Fig. 15, *M*. Antennal scale extending beyond the distal end of antennular peduncle. Mandible without palp. Endopodite of first maxilliped provided with a rather small lobe-like process at distal outer angle (Fig. 5, *L*). First pereiopod with proportions against finger : palm 1.1, carpus 1.9, merus 1.9 ; carpus moderately excavated on distal anterior border. Second leg much longer than first, with ratios to finger : palm 0.7, carpus 2.2, merus 2. Third stouter than second. Fourth as stout

as third, dactylus with 7 spinules on posterior border; propodus armed with 15 setae on its posterior border, length about 15.5 times the breadth; carpus about 0.5 times as long as propodus, with 3 feeble spines, 1 very stout almost terminal one on posterior border; merus about 1.2 times as long as propodus with 3 spines on posterior border (Fig. 15, *D*). Fifth pair similar to preceeding two, dactylus with about 50 spines on posterior border (Fig. 15, *E*). Endopodite of first pleopod leaf-shaped, giving off a stylamblys at distal inner angle in grown-up male (Fig. 15, *G*), but simply elongated in full grown female (Fig. 15, *K*).

Localities: Izumi, Kimmura, Nakizin, Tengagawa (Okinawa-zima).

Distribution: Liu-Kiu (Stimpson).

Note: Stylamblys of first pleopod is not yet present in an inmature male about 13 mm in body length without rostrum (Fig. 15, *F*). Endopodite of first pleopod of an inmature female about 13 mm

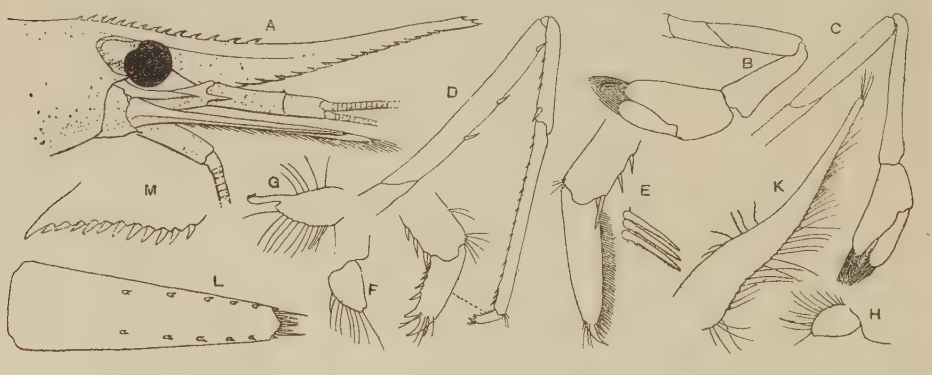

Fig. 15. *A*, Frontal aspect of *C. grandirostris*, ♀, ×7; *B*, first pereiopod, ×ca. 13; *C*, second pereiopod, ×10; *D*, fourth pereiopod, ×10; *E*. ultimate segment of fifth leg, ×ca. 33; *F*, endopodite of first pleopod of male body length 13.2 mm, ×ca. 33; *G*, same as in *F*, body length 15.5 mm; *H*, same as in *F*, female, 13.0 mm, ×ca. 33; *K*, same as in *H*, 22.0 mm, ×ca. 33; *L*, telson, ×10; *M*, uropodal spine, ×ca. 33.

in body length excluding rostrum, somewhat oval in outline just like that of inmature male (Fig. 15, *F*).

In his description of *C. grandirostris*, Stimpson puts: "Rostrum carapace vix brevius,...crista dorsali supra oculos fere recta et denticulis minutis ab 20 serrata, denticulo postico supra basim pedunculorum oculorum sito; cristae parte quarta anteriore edentula, denticulo uno mediano et duobus apicalibus exceptis; rostri margine inferiore obscure

8—10-denticulato." It may be mentioned that my specimens stand at variance with his account in having (1) rostrum not shorter than carapace; (2) upper rostral spines 14 to 22 and lower ones 10~20; (3) upper border of rostrum unarmed in distal half.

Caridina leucosticta Stimpson

Caridina leucosticta Stimpson, 1860, p. 28; Rathbun, 1902, p. 49.
Caridina nilotica gracilipes, Uéno, 1935, p. 272, Fig. 2.

Carapace with antennal spine, but without supraorbital spine, anterolateral margin rounded. Rostrum as long as carapace, subhorizontal but slightly concave near the middle of the upper border, passing proximally into a low and short ridge on carapace, dorsally with 15~23 (mostly 20, 19.8 on average) spines, 2 or 3 of which are placed on the ridge, with 1~3 (mostly 1, 1.5 on average) isolated spines at tip and ventrally with 6~22 (mostly 12, 10.3 on average) spines. (See below).

	Range	Mean	C. D.	C. V.
Upper	15~23	19.8±0 23	2.08±0.19	10.5±0.84
Tip	1~3	1.5±0.08	0.06±0.05	4.3±0.39
Lower	6~22	10.3±0.46	0.41±0.33	3.9±0.31

(Specimens, 50).

Telson slender, three times as long as wide (proximally), ratio of proximal border to distal border 5 : 2, dorsally armed with three pairs of spinules, terminally with 9 setae (Fig. 16, *K*). Antennal peduncle shorter than rostrum. Antennal scale somewhat extending beyond tip of rostrum. Mandible without palp. Endopodite of first maxilliped with a lobe-like protuberance at outer distal angle (Fig. 5, *K*). First leg the shortest of all; ratios to finger: palm 1, carpus 1.5, merus 1.7; carpus somewhat excavated on distal border. Second leg much longer than first, ratios to finger: palm 0.7, carpus 1.8, merus 1.7; merus about 5 times as long as wide. Third leg much longer than second cheliped; dactylus about one-fourth the length of propodus, with 6~7 spines on posterior border, propodus 12.5 times as long as wide, with terminal one pair of longer setae and many shorter irregularly set setae on its posterior border, carpus about 0.6 times as long as propodus; merus somewhat longer and stouter than propodus, with a spine on posterior border. Fifth leg fringed with about 50~60 setae on posterior border of dactylus (Fig. 16, *E*). Endopodite of first pleo-

pod without stylamblys in full grown male specimens (Fig. 16, *G* and *H*), but much longer than female, ending very acutely (Fig. 16, *F*).

Fig. 16. *A*, Frontal aspect of *C. leucosticta*, ♀; *B*, chela of first leg; *C*, chela of second leg; *D*, terminal segment of third leg; *E*, dactylus of fifth leg; *F*, first pleopod; *G*, second pleopod; *H*, endopodite of second pleopod.

Localities: Yuda (Itiki), Kagosima Pref.; Midori-kawa, Kumamoto Pref.; Nagasaki; Kurume, Yukuhasi, Hukuoka Pref.; Yosino-gawa, Tokusima Pref.; Miya, Aiti Pref.; Yaidu, Simoda, Siduoka Pref.; Murakami, Niigata Pref.

Distributions: Liu-Kiu(Stimpson); Kurume (Rathbun).

Note: The present species is closely allied to, if not identical with, the typical form of *C. nilotica* Roux and its subspecies especially *C. nilotica gracilipes* de Man. It may be mentioned that the Formosan specimens which Dr. Uéno (1935) had referred to *C. nilotica gracilipes* were kindly placed by him at my disposal and they revealed nothing different from other places of Japan which

Species	Size of egg (mm)		Investigator	Locality
	length	breadth		
C. nilotica	0.70~0.86	0.42~0.48	de Man	Cairo.
C. nil. natalensis	0.42~0.46	0.24~0.29	"	Natal.
C. nil. paucipara	0.96~1.10	0.55~0.67	"	"
C. nil. longirostris	0.33~0.39	0.21~0.26	"	Macta, near Oran.
C. nil. bengalensis	0.42~0.49	0.25~0.30	"	Bengal.
C. nil. brachydactyla	0.39~0.49	0.22~0.25	"	Celebes, Saleyer, Flores.
C. nil. gracilipes	0.35		"	Celebes, Saleyer.
" "	0.50~0.52	0.31~0.32	Kemp	Shanghai.
C. nil. minahassa	0.55		de Man	Minahassa, Saleyer.
C. leucosticta	0.60~0.50	0.30~0.37	Kubo	Kotôsi (Formosa).
" "	0.35~0.48	0.20~0.29	"	Miya (Aiti Prefecture).

are referred to *C. leucosticta* in the preceeding paragraphs. The egg size has been utilized, amongst others, to distingnish *C. lencosticata* from *C. nilotica* and its subspecies. But as shown in the preceding table, no decided differences could be found, not to mention that the apparent differences in egg size might be due to differences in developmental stages.

Caridina japonica de Man

Caridina japonica de Man, 1892, P. 261, Taf. 9, Fig. 7; Balss, 1914, P. 25.

Rostrum about 0.6 times as long as carapace, a little ascending at base but otherwise stretching almost horizontally, serrated with 13~25

Fig. 17. *Caridina japonica* de Man, ♀, ×1.2.

spines on dorsal except its anterior one-third, with 4~14 spines on ventral. Antennal spine present but supraorbital one absent, antero-

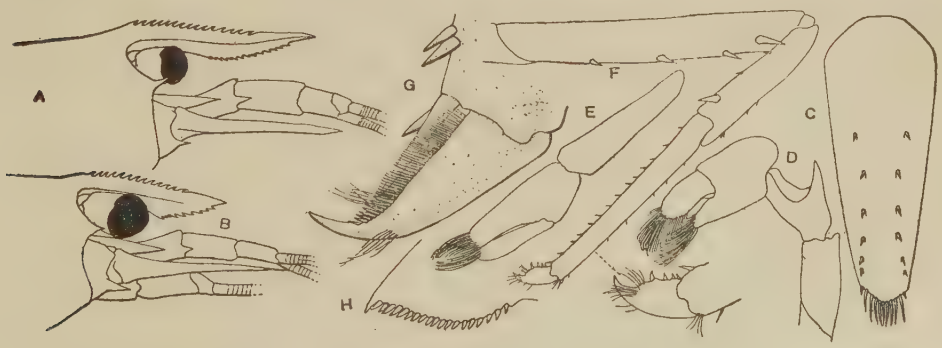

Fig. 18. *A*, Frontal aspect of *C. japonica*, ♀, ×4; *B*, same as in *A*, (variety), ×4; *C*, telson, ×7; *D*, first cheliped, ×7; *E*, terminal three joints of second cheliped, ×7; third leg, ×7; *G*, dactylopodite of fifth leg, ×ca. 33; *H*, uropodal spines, ×ca. 13.

lateral margin not spiniform. Mandible without palp. Endopodite of first maxilliped with a lobe-like process at the distal outer angle (Fig. 5, *G*). Telson with 6 pairs of spinules in distal three-fifths, with 11 spinules on obtusely convex terminal margin (Fig. 18, *C*). First cheliped the shortest of all thoracic legs, with palm 1.5, carpus 1.5 and merus 1.9 in finger, carpus excavated anteriorly (Fig. 18, *D*). Second cheliped much longer than the first one, palm about 0.7, carpus 1.7, times as long as dactylus (Fig. 18, *E*). Third leg shorter and much longer than second one; dactylus with 4, propodus with 14 spinules on each posterior border; carpus about 0.6 times as long as propodus, with subterminal spine on posterior border; merus about 1.5 times the length of propodous, with 4 spines on posterior border (Fig. 18. *F*). The remaining two pairs of pereiopods similar, except dactylus of the fifth leg mostly subtriangular, fringed with 54 spinules on the posterior border, and with a recurved hook at tip (Fig. 18, *G*). Endopodite of the first pleopod of male with rounded apex which is surpassed by a long protuberance growing from distal inner angle (Fig. 19, *A*), same of female acuminate at tip without any protuberance (Fig. 19, *C*). Endopodite of second pleopod provided in male with bar-shaped stylamblys and appendix masculina which is twice as long as stylamblys and armed with a tuft of setae at apex (Fig. 19, *B*), same in female with a longer stylamblys only (Fig. 19, *D*).

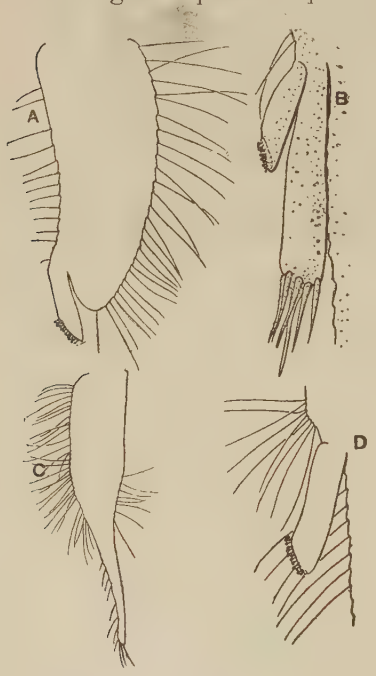

Fig. 19. *A*, Endopodite of first pleopod of *C. japonica*, ♂, ×40; *B*, stylamblys and appendix masculina, ×40; *C*, same as in *A*, ♀, ×16; *D*, stylamblys of second pleopod, ♀, ×28.

Localities: Tanabe, Wakayama Pref.; Okinawa-zima (Liu-Kiu).

Distributions: Japan (de Man), Sagami Bay (Balss).

Note: This species may be distinguished from *C. weberi*[33] by having dactylopodite of fifth leg subtriangular in outline and from *C. laevis*[33] by having such a characteristic form of dactylopo-

dite of the appendage in question but no spine on median ridge of carapace.

Caridina japonica sikokuensis subsp. nov.

Carapace about 4 times as long as rostrum. Rostrum short, not reaching to the distal border of the basal segment of antennular peduncle, directed strongly downwards, armed with 21 spines on almost whole dorsal border, with 13 spines on subterminal portion of lower border (Fig. 20, *A* and *B*). Antennal spine present, pterygostomian angle rounded. Telson much shorter than uropods, with a longitudinal series of 6 pairs of spinules toward dorsal end, with 7 long, 2 short satae on rectangularly pointed terminal margin (Fig. 20, *C*). Mandible

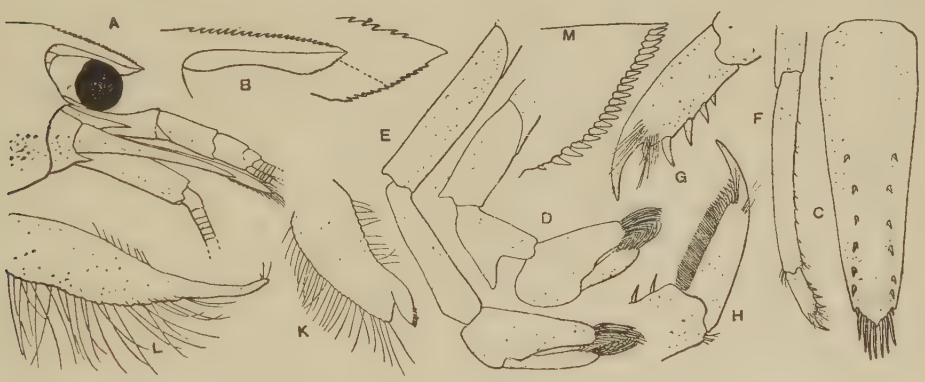

Fig. 20. *A*, Frontal aspect of *C. japonica sikokuensis*, ♂, ×7; *B*, rostrum and its tip, ×ca. 13; *C*, telson, ×ca. 13; *D*, first thoracic leg, ×10; *E*, second thoracic leg, ×10; *F*, distal two segments of third leg, ×10; *G*, dactylus of third leg, ×ca. 33; *H*, dactylus of fifth leg, ×ca. 33; *K*, endopodite of first abdominal appendage, ♂, ×ca. 23; *L*, same as in *K*, ♀, ×ca. 23; *M*, uropodal spines, ×ca. 13.

without palp. Endopodite of first maxilliped with a papilliform protuberance projecting from the distal outer angle (Fig. 5, *F*). First cheliped the shortest, palm 0.9, carpus 1.2, merus 1.7 in finger, carpus excavated on anterior border. Second cheliped a little longer than 1.5 times the length of the first one, palm in finger 0.6, carpus 1.6, merus 1.9. Third leg slightly longer than 1.4 times the length of the second; dactylus with 5 spinules on posterior border; propodus about thrice as long as dactylus, with 9 spinular setae on posterior border (Fig. 20, *F* and *G*). Fourth leg almost the same as the third leg in

shape and size. Dactylus of fifth leg fringed with 56 long setae on the posterior border (Fig. 20, *H*). Endopodite of first abdominal appendage lobe-like, provided in male with a stylamblys at distal inner angle (Fig. 20, *K*), but simply lanceolate in female (Fig. 20, *L*).

The description given above is based on a male specimen of 29.5 mm, and a female ovigerous specimen of 30.5 mm in body length from posterior margin of orbital notch to tip of telson.

The present subspecies is closely allied to the typical form of *Caridina japonica* de Man, but it is easily distinguished from it by having rostrum exceedingly short and directed strongly downwards.

Type locality: Ryûgadô, Kôti Prefecture (Mr. K. Mori).

Caridina serratirostris de Man

Caridina serratirostris de Man, 1892, p. 382, Pl. 23, Figs. 28 and 28 (a–h).
Edmondson, 1935, p. 8, Fig. 2 (g–l).

Carapace with antennal spine, without supraorbital one, pterygostomian angle not spiniform. Rostrum almost horizontal, but slightly descending distally, about 0.5 times as long as carapace, with 23 spines on upper border and median ridge of carapace, with 5 spines on lower

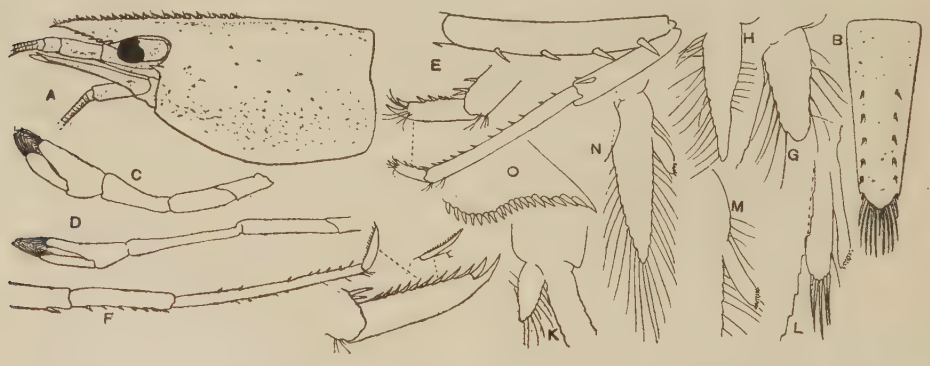

Fig. 21. *A*, Profile of cephalo-thorax of *C. serratirostris*, body length 14 mm, ♀, ×7; *B*, telson, ×ca. 13; *C*, first cheliped ×ca. 13; *D*, second cheliped, ×10; *E*, third thoracic leg, ×ca. 16; *F*, terminal three segments of fifth leg (×ca. 16) and its dactylus (×ca. 66); *G*, endopodite of first abdominal appendage, ♂, ×ca. 66; *H*, same as in *G*, ♀, ×ca. 33; *K*, same as in *H*, body length, 10.5 mm, ×ca. 33; *L*, stylamblys and appendix masculina of ♂, 9 mm in body length, ×ca. 66; *M*, stylamblys of second pleopod in female, ×ca. 33; *N*, endopodite of second abdominal appendage of 10.5 mm in body length, ♀, ×ca. 33; *O*, uropodal spines, ×ca. 33.

border (Fig. 21, *A*). Telson dorsally armed with a longitudinal series of 5 pairs of spinules, and with 11 long, 2 short spinular setae on convex distal border (Fig. 21, *B*). Antenular peduncle extends slightly beyond tip of rostrum ; stylocerite overlapping second joint of antennular peduncle by one-fourth. Mandible without palp. Endopodite of first maxilliped with a lobe-like process at distal outer angle (Fig. 5, *H*). First cheliped the shortest of all pereiopods ; palm in finger 0.6, carpus 1.2, merus 1.2, ischium 0.7 ; carpus not excavated on distal border (Fig. 21, *C*). Second cheliped slender, much longer than first, palm in finger 0.6, carpus 2, merus 1.7 (Fig. 21, *D*). Third leg stouter than second one ; dactylus about one-fourth the length of propodus, with 6 spinnules on posterior border ; propodus with 13 spinules on posterior ; carpus about two-thirds the length of propodus, with a subterminal spinular seta ; merus about 1.3 times as long as propodus, with four spinules on posterior border (Fig. 21, *E*). Fourth leg much resembles third one. Fifth leg somewhat slenderer than previous two pairs of legs, dactylus about one-fourth the length of propodus, with 10 spinules on posterior border (Fig. 21, *F*), dactylus about one-fourth the length of propodus, with 10 spinules on posterior border (Fig. 21, *F*). Endopodite of first pleopod lobular, rounded at tip in male (Fig. 21, *G*), but pointed in female (Fig. 21, *H*). Endopodite of second pleopod armed in male with stylamblys and equally long appendix masculina which is furnished with a tuft of long setae at apex, but in female with stylamblys only (Fig. 21, *M* and *N*). Uropods with 19 spinules in both sexes (Fig. 21, *O*).

Locality : Okinawa-zima (Liu-Kiu), Dr. Yaitirô Okada.

Distributions : Saleyer, Flores (de Man) ; Jacquinot Bay, Mélanésienne ; Queensland (Roux).

Note : Remarkably enough, posterior border of dactylus of fifth leg is furnished with 10 spinules in the present species instead of 30~65 spinules as in other species belonging to genera, *Paratya*, *Caridina*, *Neocaridina* and *Atya*.

Genus ***Atya*** Leach, emend.

Atya Leach, 1815, p. 345; Newport, 1847, p. 158; de Haan, 1849, p. 185; Bate, 1888, p. 691; de Man, 1892, p. 355; 1915, p. 407; Blanco, 1935, p. 30.

Antennal spine present, supraorbital one absent. Mandible without palp. Endopodite of first maxilliped provided with a lobe-like protu-

berance at distal outer angle. Both first and second chelipeds quite similar in general aspects, carpus crescent-form, chela composed of two similar fingers which are provided with a tuft of long hairs on the distal border.

Atya moluccensis de Haan

Atya moluccensis de Haan, 1849, p. 186; Miers, 1880, p. 382, Pl. 15, figs. 3 and 4; de Man, 1892, p. 357, pl. 21, fig. 20; 1915, p. 407, Taf. 28, figs. 5 and 5a~d; Bouvier, 1904, p. 137; Balss, 1914, p. 26; Blanco, 1935, p. 30.

Body large, entirely covered with fine spinules. Rostrum rather short, triangular in upper aspects, more or less deflexed, slightly shorter than 0.4 times the length of carapace, not reaching to the ter-

Fig. 22. *Atya moluccensis* de Haan, ♀, ×ca. 1.2.

minal margin of penultimate article of antennular peduncle, dorsal carina extending backwards to post-orbital region (Fig. 22), spineless dorsally, but with 8 spines ventrally (see below).

Number of lower rostral spines	3	4	5	6	7	8
Frequency	2	5	7	2	2	2

Infraorbital and pterygostomian angles each end in an acute spine (Fig. 23, *A*). Telson shorter than uropods, with two longitudinal series of 6~7 spinules on dorsal with a median and two marginal processes on distal convex border which bears several bristles (Fig. 23, *B*).

Mandible without palp (Fig. 23, *C* and *D*). Endopodite of first maxilliped with a lobular triangular process at distal angle. Chelipeds. quite similar in size and general aspects, carpus deeply excavated on anterior border, fingers similar (Fig. 23, *E* and *F*). Third to fifth pairs of legs much alike, densely covered with setae all over. Third leg stoutest of all walking legs, propodus in dactylus about 2.8, carpus 2, merus 6; carpus with a subterminal spine on the posterior border,

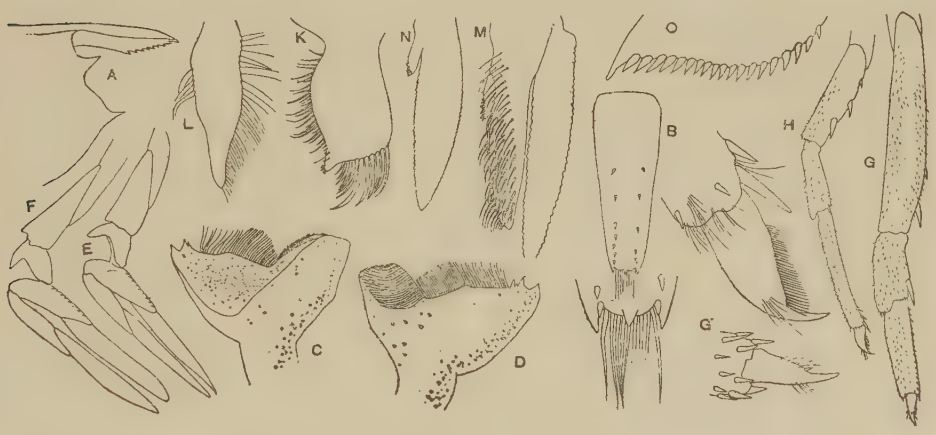

Fig. 23. *A*, Frontal region of carapace of *A. moluccensis*, ♀, ×4; *B*, telson, ×4; *C*, inner view of mandible, ×ca. 16; *D*, outer view of mandible, ×ca. 16; *E*, first leg, ×4; *F*, second leg, ×4; *G*. third leg, ×4; *G'*, dactylus of third leg, ×ca. 13; *H*, fifth leg, ×4; *H'*, dactylus of fifth leg, ×ca. 23; *K*, endopodite of first pleopod in male, ×ca. 13; *L*, same as in *K* in female, ×ca. 16; *M*, endopodite of second pleopod in male with stylamblys and appendix masculina, ×ca. 13; *N*, endopodite of second pleopod in female with stylamblys, ×7; *O*, uropodal spines, ×ca. 13.

merus with one small spinules and one large spine on the posterior border (Fig. 23, *G*). Fifth leg smaller and shorter (about 0.8 times) than third and fourth ones, propodus in dactylus 4, carpus 2, merus 3; dactylus armed with 32 setae in distal two-thirds of the posterior border except apical claw, carpus with a subterminal spinule on posterolateral side, merus furnished with 3 spinules on posterior border (Fig. 23, *H*).

Definite branchiae two in number.

	h	*i*	*k*	*l*	*m*	*n*	*o*
Pleurobranchiae	—	r	1	1	1	1	1
Arthrobranchiae	—	1	1	—	—	—	—
Podobranchiae	—	—	—	—	—	—	—
Mastigobranchiae		r?	r	r	—	—	—
Exopodite	1	1	—	—	—	—	—

Endopodite of first pleopod resembles a sail of a boat in outline, with a short papilliform protuberance at inner distal corner, densely furnished with bristles on inner and terminal borders in male (Fig. 23, *K*), but in female, with long hairs on whole outer and central inner borders, both meeting acutely at tip (Fig. 23, *L*). Endopdite of second pleopod provided with a large appendix masculina as well as small stylamblys on its inner side, the former thickly set with setae (Fig. 23, *M*), but in female, with a stylamblys only (Fig. 23, *M*). Uropod with 19 spines (Fig. 23, *O*).

Above description is based on a male, 31 mm long, and an ovigerous female specimen, 51 mm in body length from posterior margin of orbital notch to the tip of telson.

Localities: Okinawa-zima, Miyako-zima, Isigaki-zima (Liu-kiu).

Distributions: Java; Sumatra; Celebes; Saleyer; Timor; Flores (de Man); Philippine (Blanco).

Note: Accoding to Mier's[37] descriptions and illustrations which are based on an adult male from Java, "the third leg considerably dilated, and the merus armed below with a strong spine placed at some distance from the distal border of the segment". But my specimens have two unequall spinules instead of a strong spine in corresponding part of third leg which is not dilated.

III. General consideration

So far as my observations on the majority of the family Atyidae go, two modes of subdivisions may be recognized in this family, viz., geographical and morphological. The geographical distribution of the group warrants one to set five subgroups into which the group in question is divided, namely, (1) Korean, (2) All Japan, (3) Nothern Japan, (4) Southern Japn, and (5) Subtropical and tropical Japan.

(1) Korean subgroup includes one which is endemic to Korea, *Neocaridina denticulata koreana*.

(2) All Japan subgroup covers the whole Japan in the extent of

distribution and is represented by *Caridina leucosticta*, *Paratya compressa* may also be said a member of this subgroup but it is not yet found more southern than Kyûsyû.

(3) Northern Japan subgroup extends from the latitude 35° northward to northern extremity of the Main Island of Japan in area and is inhabited by a subspecies of *P. compressa*, viz., *P. compressa improvisa*.

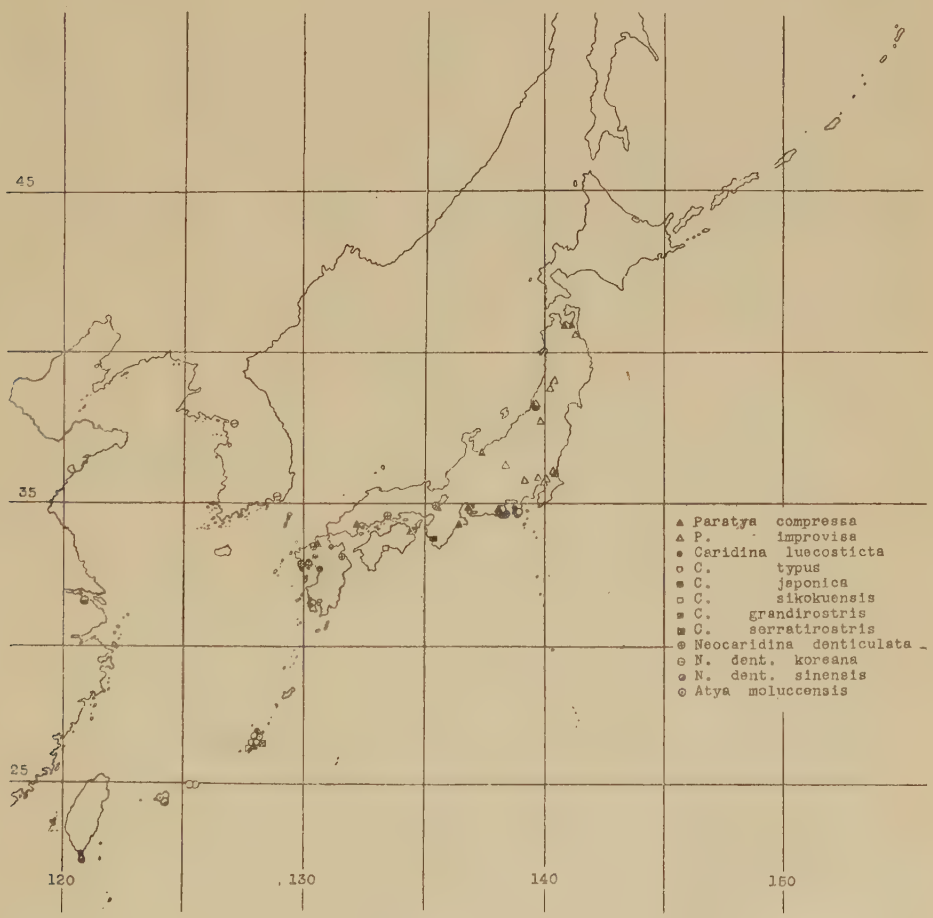

Fig. 24. Distribution of Japanese atyid shrimps.

(4) Southern Japan subgroup includes those which inhabit southern Japan, viz., *Caridina typus*, *C. japonica*, *C. japonica sikokuensis* and *Neocaridina denticulata*.

(5) Subtropical and tropical subgroup populates from Liu-kiu southward to Indian Ocean, including *Caridina grandirostris*, *C. serratirostris*, *Neocaridina denticulata sinensis*, and *Atya moluccensis*.

Of the morphological features which correspond to the geographical distribution of the specimens, mention should be made of the typical form of *Paratya compressa* and *P. comp. improvisa* on the one hand, and the typical form of *Neocaridina denticulata*, and its two subspecies *N. dent. koreana* and *N. dent. sinensis* on the other.

The two items do not go on all fours except the above mentioned examples. But I would like to call attention to the point that *Paratya compressa* stands far apart from all the rests in having exopodites on all pereiopods. But *Atya* is rather near to *Caridina* with respect to the features of appendages. It may be mentioned that pleopods furnish conjectures as to the phylogeny of the group. I am inclined to set "leucosticta" form ancestral to two divergent stems "denticulata" and "typus" according to the features of pleopods. It is hoped, however, that careful examinations will throw some light on this problem.

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Notes on the Sexual Dimorphism of the Spiny Lobster, *Panulirus japonicus* (v. SIEBOLD)*

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(Received Nov. 24, 1937)

The sexual dimorphism in the decapod crustaceans is rather scantily known. For elucidation of the phenomenon in question one should resort to some means other than ordinary superficial observation. Biometry may prove useful as one of the weapons in attacking the probrem.

Recently, attention of the present author was called to the fact that two forms of the spiny lobster live in the Japanese waters. Both the two can be distinguished, amongst others, by the relative length of the walking legs.

A careful examination of a considerable number of specimens has convinced the present author that both the two are nothing more than the two sexes of one and the same species, *Panulirus japonicus*.

With a view to studying the sexual differenciations of the species in detail, several biometric constants were computed with the results given in this paper.

The present author must give his hearty thanks to Professor Arata TERAO for his kind supervison during the course of this study. He also fully appreciates kindness of Messrs. Turumatu KIKUTI, Densaburô INABA and Yuduru MATSUMURA given me in various ways.

Material and Methods

The material, on which the present paper is based, was obtained from various parts of Japan, from Kyûsyû to Tokyô. They amount to 97 in number, including 56 males and 41 female, and range from 98 mm to 328 mm in length. They were preserved in alcohol and measured thereafter. No live material was used.

Body length was measured from frontal margin of carapace to distal

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end of telson, width of carapace measured at level of cervical groove, breadth of abdomen from one tip to the other tip of the pleura of first abdominal segment.

Relative Growth of Bodily Parts

Since the age of the material was not known, all the measurements were related to the total length. As illustrated in Fig. 1, both

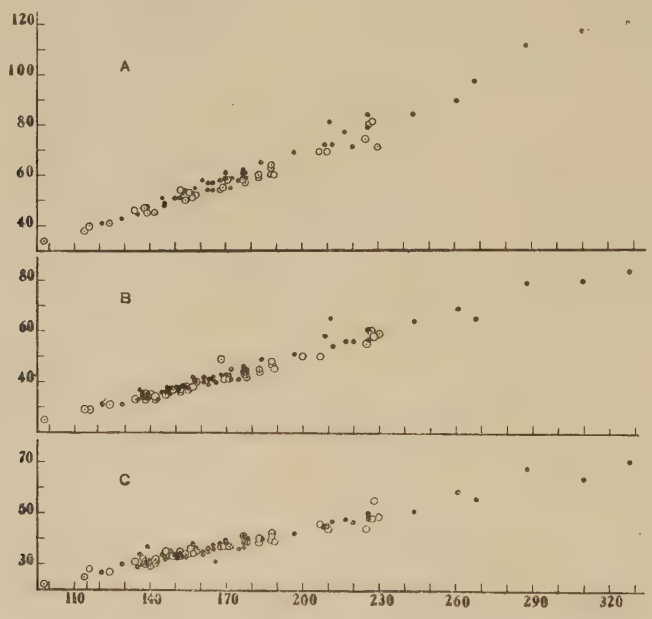

Fig. 1. Showing dimensions (in mm) in relation to body length. *A*, length of carapace; *B*, width of carapace; *C*, width of abdomen.

sexes can not be distinguished in relative growth of length and width of carapace, and of width of abdomen.

But antenular peduncle, especially its basal segment, serves to distinguish one sex from the other. As shown in Table 1, and Fig. 2, the male has relatively longer antennular peduncle than the female.

The sexual dimorphism in relative length of legs is, as already remarked, evident, longer in male than in female (Fig. 3).

The relative growth of the joints of the walking legs furnishes

also an evidence for the existence of sexual dimorphism. Of all the

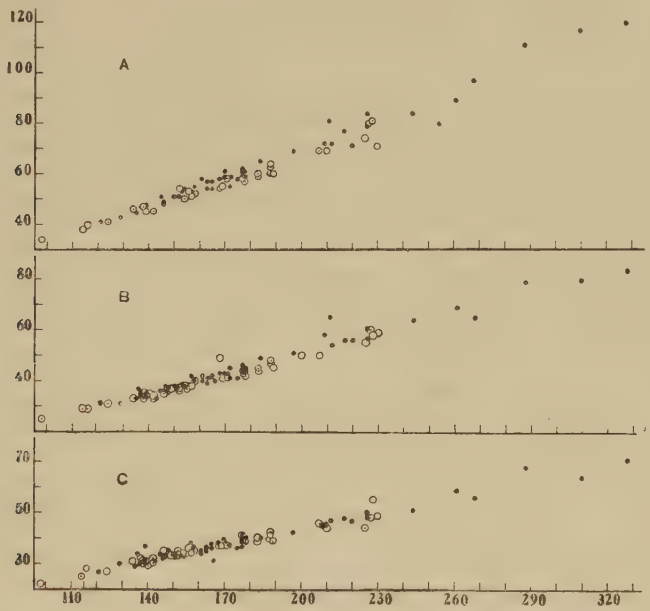

Fig. 2. Showing dimentions (in mm) of length of antennular peduncle and some others in relation to body length; *A*. antennular peduncle; *B*, basal segment of antennular peduncle; *C*, penultimate segment of same one. *D*, fourth leg; *E*, fifth leg.

Table 1.

Items	Mean		Standard deviation		Coefficient of variation	
	♂	♀	♂	♀	♂	♀
A	178.41±4.16	163.82±5.01	46.22±2.94	47.06±3.54	25.90±1.75	29.05±2.33
B	63.26±1.91	50.95±1.25	21.23±1.35	11.93±0.88	33.56±2.36	23.42±1.83
C	95.87±3.14	74.60±2.06	34.61±2.22	18.63±1.46	36.10±2.60	24.97±2.07
D	128.66±4.68	95.51±2.25	51.06±3.31	19.75±1.59	39.68±2.95	20.67±1.73
E	116.00±3.70	92.78±2.23	40.35±2.61	20.44±1.57	34.78±2.51	22.03±1.78
F	96.25±2.43	81.18±1.58	26.98±1.71	14.50±1.12	28.09±1.92	17.86±1.42
G	82.26±2.23	67.48±1.54	24.15±1.58	14.26±1.08	29.36±2.08	21.13±1.74

A, Aody length; *B*, length of antennule; *C*, length of first leg; *D*, length of second leg; *E*, length of third leg; *F*, length of fourth leg; *G*, length of fifth leg.

Table 2.

sex	Correlation coefficient					
	r A B	r A C	r A D	r A E	r A F	r A G
♂	0.90±0.01	0.94±0.01	0.99±0.00	0.88±0.02	0.96±0.00	0.95±0.00
♀	0.47±0.08	0.57±0.07	0.39±0.09	0.36±0.09	0.50±0.09	0.82±0.03
sex	Mean ratios of several parts to body length					
	B/A	C/A	D/A	E/A	F/A	G/A
♂	0.35±0.05	0.52±0.07	0.69±0.10	0.64±0.11	0.53±00.4	0.45±0.04
♀	0.32±0.09	0.37±0.10	0.61±0.18	0.60±0.01	0.52±0.01	0.42±00.0

A, B, C,.....G. same as in table 1.

joints, the merus is the most striking in this respect (Fig. 4) decidedly longer in male than in female.

Remarkably enough, significant correlation was always observed in male and the values of the coefficients are much higher in male than in female (Table 2). An almost complete correlation exists between body length and second leg in male (Table 2).

It has been known that *Panulirus japonicus* attains sexual maturity

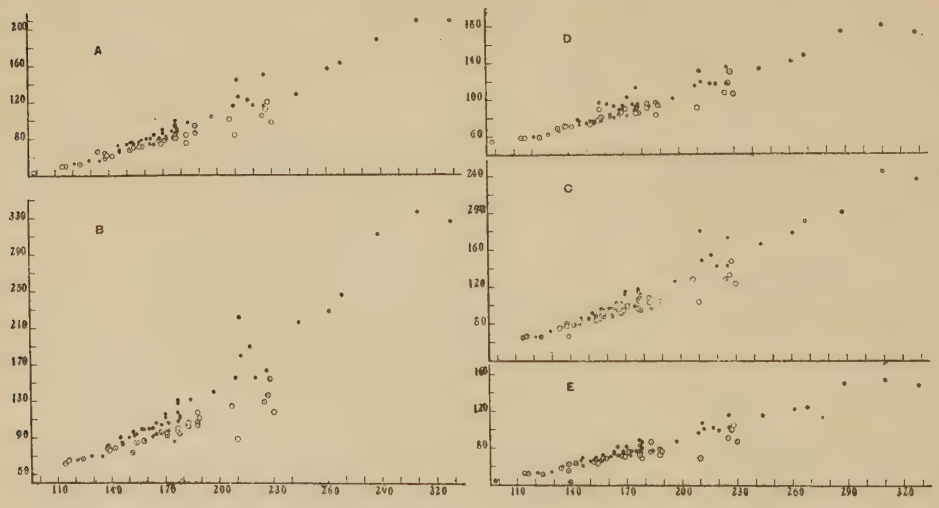

Fig. 3. Showing dimensions (in mm) of the length of all thoracic legs in relation to body length. *A*, first leg; *B*, second leg; *C*, third leg; *D*, fourth leg; *E*, fifth leg.

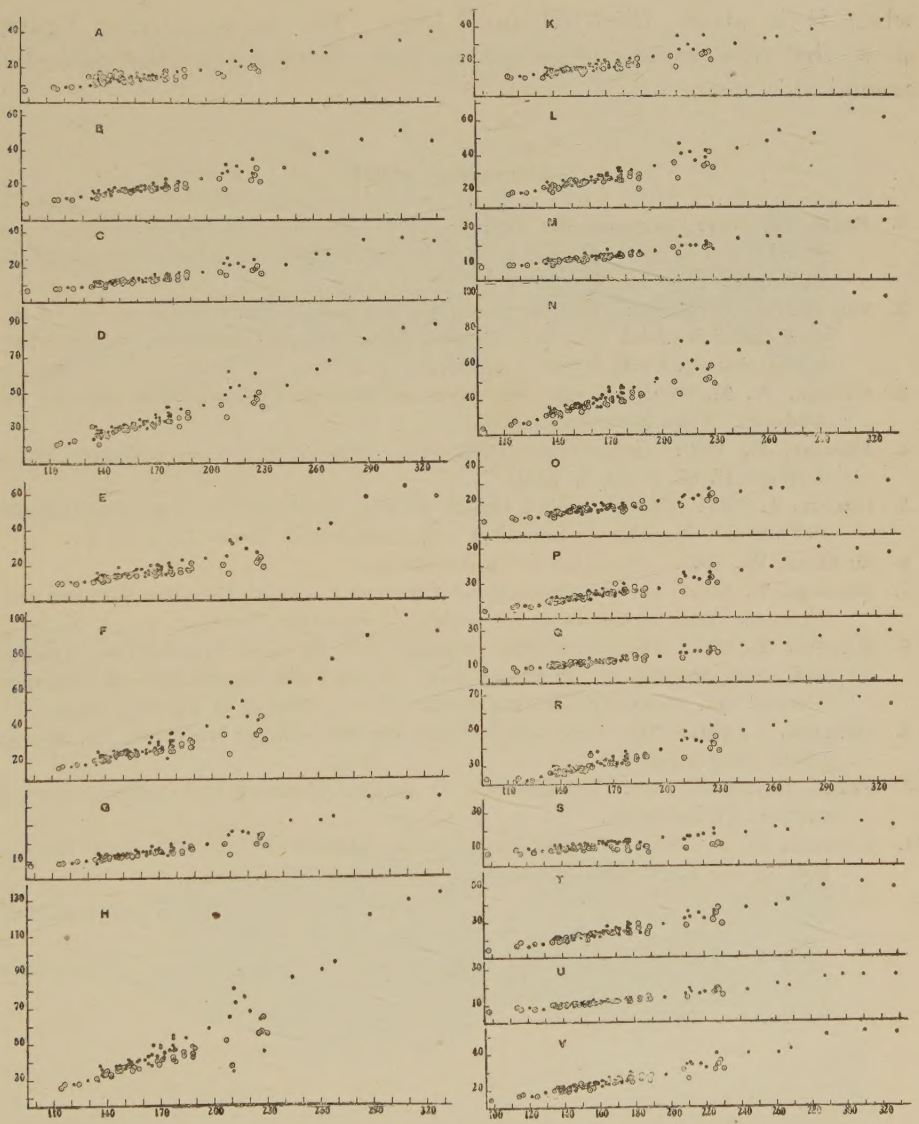

Fig. 4. Showing dimensions (in mm) of the length of distal four segments of all thoracic legs in relation to body length. *A*, dactylus of first leg; *B*, propodus of same leg as in *A*; *C*, carpus of same leg as in *A*; *D*, merus of same leg as in *A*; *E*, dactylus of second leg; *F*, propodus of same leg as in *E*; *G*, carpus of same leg as in *E*; *H*, merus of same leg as in *E*; *K*, dactylus of third leg; *L*, propodus of same leg as in *K*; *M*, carpus of same leg as in *K*; *N*, merus of same leg as in *K*; *O*, dactylus of fourth leg; *P*, propodus of same leg as in *O*; *Q*, carpus of same leg as in *O*; *R*, merus of same leg as in *O*; *S*, dactylus of fifth leg; *T*, propodus of same leg as in *S*; *U*, carpus of same leg as in *S*; *V*, merus of same leg.

when it is about 150~160 mm [8] long. The accompanying figures show that the trends of growth in both sexes are a little separated around this stage.

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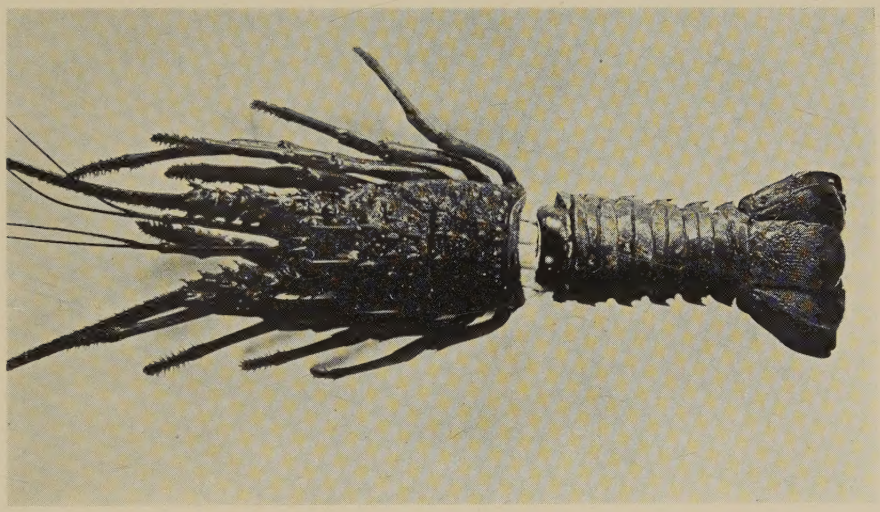

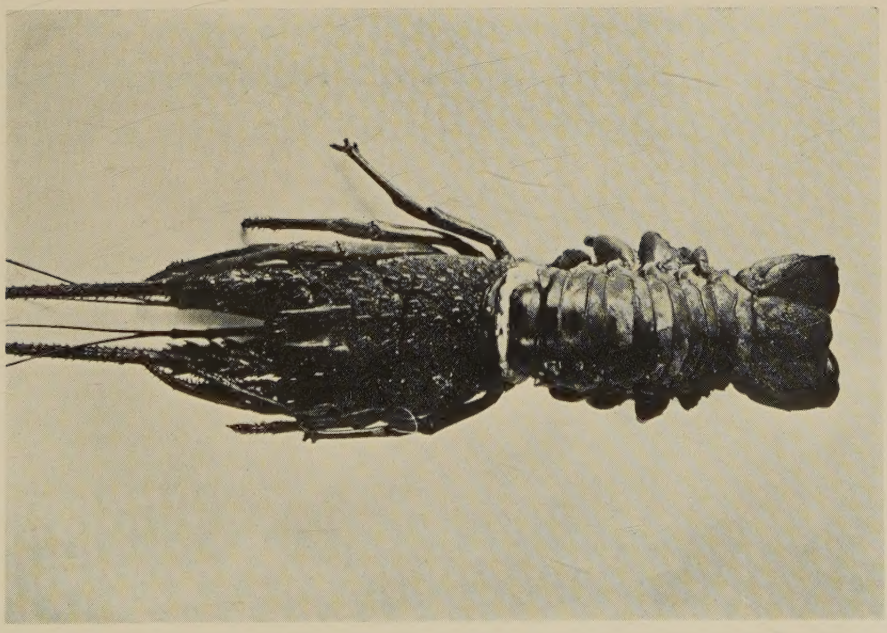

Panulirus japonicus (v. Siebold). Upper, male, 230 mm in body length; lower, ovigerous female, 228 mm in body length.